CHECK LIST OF THE BRENTHIDAE OF OCEANIA

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BERNICE P. BISHOP MUSEUM

OCCASIONAL PAPERS

VOLUME XI, NUMBER 1

HONOLULU, HAWAII

PUBLISHED BY THE MUSEUM

1935

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SAMENPRÜFUNGSSTELLE UND PATHOL. VERSUCHSTATION
STETTIN, GERMANY

Die aus Oceanien bisher bekannt gewordenen Brenthiden sind circa 60 Arten, das sind noch nicht 5% der bekannten. Es kann keinem Zweifel unterliegen, dass bei weiterer Durchforschung dieses grossen, und vor allen Dingen interessanten, Gebietes sich die Artzahl erweitern wird. Der Faunencharakter kann aber als feststehend angesehen werden.

In früheren Arbeiten habe ich mehrfach darauf hingewiesen, dass sich bei den Brenthiden mehrere vermutliche Enstehungszentren erkennen lassen. Von diesen sind die Ithystenini sicher austromalayisch. Es ist daher auch kein Zufall, dass sich verhältnissmässig zahlreiche Vertreter in Oceanien wiederfinden. Im übrigen sind es orientalische Elemente. Ubiquisten sind nur zwei aufgefunden worden und auch diese nur im westlichsten Teil des Gebietes. Auf den Marquesas-Inseln fand sich die Gattung *Brenthus,* also einen Vertreter des neotropischen Gebietes. Es ist immerhin von Interesse und Wichtigkeit, zu sehen, wie weit sich die neotropische Fauna nach Westen erstreckt.

In ganz Oceanien sind Brenthiden aufgefunden worden, nur auf Hawaii fehlen sie völlig. Da die Inseln aber sicher mit am besten durchforscht sind, muss man annehmen, dass Brenthiden tatsächlich fehlen. Vielleicht ist die geologische Entstehung der Inseln daran Schuld. Eigenartig bleibt die Tatsache aber immer, da zum Beispiel die Ipiden, die zeitlich mit den Brenthiden gleichaltrig sein dürften, nicht gering an Zahl und Existenzmöglichkeiten ohne Weiteres vorhanden sind.

Die systematische Anordnung folgt dem Junk-Schenkling Catalog.

I. CALODROMINI

Genus CYPHAGOGUS Parry: 54*, p. 182, 1849
(Type, *Cyphagogus westwoodi* Parry)

Cyphagogus fijianus Kleine: 41, p. 48, fig. 1, 1928; 42, p. 51, 1928.
Fiji: Viti Levu, Colo-i Suva.

* Numbers refer to bibliography, page 13.

Cyphagogus samoanus Kleine: 44, p. 157, fig. 1, 1928.
Samoa: Upolu, Apia.

Genus **CALLIPAREIUS** Senna: 67, p. 444, 1892
(Type, *Callipareius feae* Senna)

Callipareius flavolineatus Calabresi: 6, p. 107, 1922; 42, p. 10, 1927.
New Caledonia.

II. STEREODERMINI

Genus **CEROBATES** Schoenherr: 63, p. 487, 1840
(Type, *Cerobates tristriatus* Fabricius)

Cerobates adustus Senna: 71, p. 184, 1894; 60, p. 12, 1910; 42, p. 18, 1927; 4, p. 51, 1928.
Fiji: Sigatoka.

Cerobates vitiensis Fairmaire: 13, p. 422, 1881; 14, p. 463, 1881; 72, p. 222, 1895; 8, p. ccciv, 1895; 60, p. 12, 1910; 42, p. 19, 1927.
Fiji.

III. TRACHELIZINI

Genus **TRACHELIZUS** Schoenherr: 63, p. 489, 1840
(Type, *Trachelizus bisulcatus* Fabricius)

Trachelizus bisulcatus Fabricius: 10, p. 548, 1801; 50, p. 67, 1802; 61, 1833; 62, p. 491, 1840; 22, p. 265, 1837 (*impressus*); 59, p. 206, 1885 (*bicanaliculatus*); 76, p. 301, 1899; 59, p. 206, 1885 (*semivelatus* [Miolispa]); 76, p. 301, 1899; 49, p. 636, 1895, sub *Ceocephalus* (*exophthalmus*); 60, p. 13, 1910; 42, p. 22, 1927.
Solomons: Bougainville.

Genus **MICROTRACHELIZUS** Senna: 68, p. 37, 1893
(Type, *Microtrachelizus lyratus* Perroud)

Microtrachelizus lyratus Perroud: 57, p. 139, 1864; 56, p. 92, 1852; 18, p. 2706, 1872; 60, p. 15, 1910; 42, p. 28, 1927; 23, p. 259, 1916.
New Caledonia.

Genus **MIOLISPA** Pascoe: 55, p. 393, 1862
(Type, *Miolispa suturalis* Pascoe)

Miolispa affinis Kleine: 34, p. 278, 1919; 42, p. 23, 1927.
Solomons.

Miolispa australiana Senna: 75, p. 278, 1897; 34, p. 266, 1919; 42, p. 23, 1927.
New Georgia: Pauru.

Miolispa fijiana Kleine: 43, p. 55, fig. 1, 1928; 79, p. 62, 1928.
Fiji.

Miolispa novae-guineensis Guérin: 20, p. 109, pl. 6, fig. 13, 1830; 75, p. 229, 1897; 60, p. 16, 1910; 34, p. 286, fig. 38, 1919; 42, p. 24, 1927; 3, p. 312, sub *Brenthus* (*puncticollis*) Boisduval; 18, p. 2710, 1872, sub *Orychodes*; 70, p. 165, sub *Miolispa*.
Solomons: Bougainville.

Miolispa papuana Kleine: 34, p. 274, figs. 31, 32, 1919; 42, p. 24, 1927.
Solomons.

Miolispa pumila Montrouzier: 52, p. 37, 1855; 48, p. 442, note 2, 1866; 18, p. 2706, 1872; 60, p. 16, 1910; 34, p. 280, figs. 35, 36, 1919; 42, p. 24, 1927.
Trobriand Islands: Woodlark. Bismarck Archipelago: New Britain; Duke of York.

Miolispa pulla Kleine: 47.
Solomons: Vanikoro.

Miolispa pygmaea Senna: 74, p. 360, 1895; 34, p. 222, fig. 3, 1919; 42, p. 25, 1927.
Bismarck Archipelago: New Britain.

Miolispa salomonensis Senna: 69, p. 1 sep., 1894; 34, p. 289, fig. 39, 1919; 42, p. 25, 1927; 77, p. 387, 1899 *Cacotrachelus sculptipennis* Sharp.
Bismarck Archipelago: New Britain; Raluno, Bainingo-Berge. Solomons: Bougainville, Vanikoro.

Miolispa strandi Kleine: 34, p. 297, fig. 43, 1919; 42, p. 25, 1927.
Bismarck Archipelago: Gazelle Island; New Britain.

Genus **STRATIOPISTHIUS** Calabresi: 5, p. 76, 1918

doriae Senna: 66, p. 254, 1892, sub *Hoplopisthius*; 5, p. 77, fig., 1918; 42, p. 30, 1927; 60, p. 15, sub *Hoplopisthius*, 1910.
Solomons: Vanikoro.

IV. AMORPHOCEPHALINI

Genus **KLEINEELLA** Strand: 78, p. 167, 1916 (1918)
(Type, *Kleineella australis* Lacordaire)

Kleineella piceonitens Kleine: 31, p. 150, figs. 57-59, 1916 (1918); 42, p. 32, 1927.
Society Islands: Tahiti: Papeete.

V. ARRHENODINI

Genus **BARYRHYNCHUS** Lacordaire: 48, p. 428, 1866
(Type, *Baryrhynchus latirostris* Gyllenhal)

Baryrhynchus indocilis Fairmaire: 15, p. 41, 1883; 12, p. 41, 1881; 51, p. 956, 1889; 60, p. 20, 1910; 29, p. 188, figs. 46-48, 1916; 42, p. 37, 1927.
Bismarck Archipelago: New Britain; Duke of York.

Baryrhynchus lineicollis Power: 58, p. 297, 1879; 60, p. 20, 1910; 29, p. 186, figs. 43-45, 1916; 42, p. 37, 1927.
Bismarck Archipelago: Gazelle Island.

Baryrhynchus schroederi Kleine: 26, p. 172, 1914; 29, p. 182, figs. 38-40, 1916; 39, p. 24, 1925; 42, p. 37, 1927.
Bismarck Archipelago: New Britain; Matupi, Massawa.

Baryrhynchus setosellus Kleine: 41, p. 49, fig. 2, 1927; 4, p. 52, 1928.
Solomons: Guadalcanal.

Genus **EUPSALIS** Lacordaire: 48, p. 430, 1866
(Type, *Eupsalis truncata* Boheman)

Eupsalis testacea Kleine: 20, p. 131, figs. 38, 39, 1916 (1917); 39, p. 25, 1925; 42, p. 39, 1927.
Bismarck Archipelago: New Britain.

Genus **CAENORYCHODES** Kleine: 35, p. 87, 1920
(Type, *Caenorychodes serrirostris* Fabricius)

Caenorychodes digramma Boisduval: 2, p. 310, pl. 7, fig. 23, 1835; 15, p. 43, 1883; 8, p. cccviii, 1895; 60, p. 26, 1910 sub *Orychodes*; 42, p. 43, 1927.

Bismarck Archipelago: New Britain; Raluno, Matupa, Kinigunang, Herbertshöhe.

Caenorychodes maasii Kleine: 40, p. 369, 1926; 4, p. 52, 1928.

Solomons: Bougainville, Guadalcanal.

VI. BELOPHERINI

Genus **ANOMOBRENTHUS** Fairmaire: 12, p. 349, 1881
(Type, *Anomobrenthus hamatirostris* Fairmaire)

Anomobrenthus hamatirostris Fairmaire: 12, p. 349, 1881; 14, p. 465, 1881; 8, p. cccviii, 1895; 60, p. 31, 1910; 42, p. 47, 1927.

Fiji.

Genus **ECTOCEMUS** Pascoe: 55, p. 388, 1862
(Type, *Ectocemus decemmaculatus* Montrouzier)

Ectocemus decemmaculatus Montrouzier: 52, p. 37, 1855; 18, p. 2710, 1872; 15, p. 42, 1883; 51, p. 955, 1889; 73, p. 562, 1894; 38, p. 161, 1923; 42, p. 51, 1927; 4, p. 52, 1928; 55, p. 388, 1862 (*wallacei*); 24, p. 169, 1909; 25, p. 49, 1875 (*pulchellus*); 19, p. 519, 1876 (*pterygorrhinus*); 1, p. 156, pl. 25, fig. 5, 1877 (*ruficauda*); 8, p. cccviii, 1895.

Bismarck Archipelago: New Britain; New Ireland; Duke of York. New Caledonia. Solomons: Bougainville, Kieta, Tulagi, Guadalcanal.

Ectocemus malcheri Kleine: 47.

Solomons: Vanikoro.

Genus **ELYTRACANTHA** Kleine: 27, p. 239, 1914.
(Type, *Elytracantha pogonocerus* Montrouzier)

Elytracantha cerberus Kleine: 32, p. 37, 1917; 42, p. 52, 1927.

Bismarck Archipelago: New Britain.

Elytracantha pogonocerus Montrouzier: 52, p. 37, 1855; 48, p. 433, note 1, 1866; 15, p. 42, sub *Ectocemus,* 1883; 51, p. 955, 1889; 60, p. 27, sub *Ectocemus,* 1910; 27, p. 233, 1914; 28, p. 59, 1915; 32, p. 37, 1917; 42, p. 52, 1927; 12, p. 349, 1881 (*spinipennis*); 8, p. cccviii, 1895.

Bismarck Archipelago: Duke of York; New Britain. Solomon Islands: Bougainville, Kieta.

VII. ITHYSTENINI

Genus BULBOGASTER Lacordaire: 48, p. 467, 1866
(Type, *Bulbogaster ctenostomoides* Lacordaire)

Bulbogaster ctenostomoides Lacordaire: 48, note 1, p. 467, 1866; 18, p. 2719, 1872; 14, p. 464, 1881; 60, p. 43, 1910; 42, p. 56, 1927; 4, p. 53, 1928; 79, p. 61, 1928.

Fiji.

Bulbogaster hebridarum Fairmaire: 11, p. 282, 1878; 8, p. cccix, 1895; 60, p. 43, 1910; 42, p. 56, 1927.

New Hebrides.

Genus ITHYSTENUS Pascoe: 55, p. 390, 1862
(Type, *Ithystenus frontalis* Pascoe)

Ithystenus bicolor Guérin: 20, p. 109, pl. 6, fig. 11 (pars), 1830; 3, p. 312, 1835; 63, p. 579, 1840; 60, p. 44, 1910; 33, p. 91, 1917 (1919); 42, p. 56, 1927.

Bismarck Archipelago: New Britain..

Ithystenus caudatus Kleine: 33, p. 100, figs. 43-45, 1917 (1919); 42, p. 57, 1927.

Bismarck Archipelago: Gazelle Island, Massana.

Ithystenus cultellatus Kleine: 33, p. 96, figs. 36-38, 1917 (1919); 42, p. 57, 1927.

Solomons: Bougainville.

Ithystenus curvidens Montrouzier: 52, p. 38, 1855; 48, p. 468, 1866; 18, p. 2720, 1872; 60, p. 44, 1910; 33, p. 83, figs. 16-17, 1917 (1919); 42, p. 57, 1927; 52, p. 39, 1855 (*guerini*); 18, p. 2720, 1872; 60, p. 44, 1910.

Bismarck Archipelago: Gazelle Island, Woodlark.

Ithystenus decorus Kleine: 33, p. 117, figs. 66-67, 1917 (1919); 42, p. 57, 1927.
Bismarck Archipelago: New Britain.

Ithystenus densepunctatus Kleine: 33, p. 89, figs. 25-28, 1917 (1919); 42, p. 57, 1927.
Solomons: Bougainville.

Ithystenus francoisi Desbrochers: 7, p. 109, 1892; 65, pp. 92, 152, 1892; 60, p. 57, 1927; 33, p. 74, figs. 7-10, 1917 (1919); 42, p. 57, 1927; 4, p. 53, 1928.
New Hebrides. Solomons: Bougainville, Vanikoro, Tulagi. Bismarck Archipelago: Gazelle Island.

Ithystenus frontalis Pascoe: 55, p. 391, 1862; 48, p. 468, 1866; 60, p. 44, 1910; 33, p. 80, figs. 12-15; 42, p. 57, 1927.
Bismarck Archipelago: New Britain.

Ithystenus hebridarum Senna: 75, p. 225, 1897; 60, p. 44, 1910; 33, p. 72, fig. 5, 1917 (1919); 42, p. 57, 1927.
New Hebrides. Solomons.

Ithystenus nigrosulcatus Fairmaire: 13, p. 421, 1881; 14, p. 462, 1881; 8, p. cccx, 1895; 60, p. 44, 1910; 33, p. 86, figs. 21-24, 1917 (1919); 42, p. 57, 1927.
Fiji. New Hebrides.

Ithystenus rugosipunctatus Kleine: 47.
Solomons: Vanikoro.

Ithystenus sabulosus Kleine: 33, p. 92, figs. 29-31 1917 (1919); 42, p. 57, 1927.
Solomons.

Ithystenus spinosus Kleine: 33, p. 69, figs. 2-4, 1917 (1919); 42, p. 57, 1927.
Solomons. Bismarck Archipelago: New Ireland.

Genus **DIURUS** Pascoe: 55, p. 392, 1862
(Type, *Diurus furcillatus* Gyllenhal).

Diurus compressicauda Fairmaire: 12, p. 349, 1881; 60, p. 45, 1910; 42, p. 59, 1927.
Caroline Islands.

VIII. PSEUDOCEOCEPHALINI

Genus **UROPTEROIDES** Kleine: 36, p. 218, 1922
(Type, *Uropteroides douei* Montrouzier)

Uropteroides douei Montrouzier: 53, p. 874, 1860; 48, p. 444, 1866; 18, p. 2717, 1872; 60, p. 40, 1910; 17, p. 164, 1911; 23, p. 259, 1916; 42, p. 61, 1927; 4, p. 53, 1928.
New Caledonia.

Uropteroides gestroi Senna: 73, p. 562, 1894; 60, p. 40, 1910; 42, p. 61, 1927.
Solomons: Vella Lavella, Guadalcanal, Kookoom.

Genus **AUTARCUS** Senna: 64, p. 59, 1892
(Type, *Autarcus laticollis* Perroud)

Autarcus laticollis Perroud: 56, p. 135, sub *Ceocephalus*, 1864; 64, p. 60, 1892; 60, p. 36, 1910; 23, p. 259, 1916; 42, p. 62, 1927.
New Caledonia: Canala.

Genus **EUBACTRUS** Lacordaire: 48, p. 456, 1866
(Type, *Eubactrus semiaeneus* Lacordaire)

Eubactrus fuscojanthinus Fairmaire: 12, p. 373, 1881; 14, p. 461, 1881; 8, p. cccix, 1895; 60, p. 39, 1910; 42, p. 62, 1927.
Fiji.

Eubactrus metallicollis Fairmaire: 12, p. 421, 1881; 14, p. 462, 1881; 8, p. cccx, 1895; 60, p. 39, 1910; 42, p. 62, 1927.
Fiji.

Eubactrus semiaeneus Lacordaire: 48; nota 1, p. 457, 1866; 18, p. 2717, 1872; 14, p. 461, 1881; 60, p. 39, 1910; 42, p. 62, 1927; 4, p. 53, 1928; 79, p. 64, 1928.
Fiji: Sigatoka, Ovalau, Matuka, Loala, Tuvutha, Munia, Lau, Rewa.

Eubactrus spissicornis Fairmaire: 12, p. 373, 1881; 16, p. 444, 1893; 8, p. cccix, 1895; 51, p. 956, 1889; 60, p. 39, 1910; 42, p. 62, 1927.
Bismarck Archipelago: Duke of York Island.

Genus **CHALYBDICUS** Kleine: 36, p. 218, 1922
(Type, *Chalybdicus hahnei* Kleine)

Chalybdicus hahnei Kleine: 36, p. 219, 1922; 42, p. 62, 1927.
New Hebrides.

Chalybdicus reverens Kleine: 44, p. 158, figs. 2-4, 1928.
Samoa: Upolu, Malololelei, altitude 2000 feet, rain forest; Savaii, Safune.

Genus **HORMOCERUS** Schoenherr: 61, p. 70, 1826
(Type, *Hormocerus reticulatus* Fabricius)

Hormocerus reticulatus Fabricius: 10, p. 552, 1801; 50, p. 81, 1802; 21, p. 360, 1833; 51, p. 956, 1889; 60, p. 36, 1910; 42, p. 63, 1927.
Solomons: Bougainville. Bismarck Archipelago: Duke of York Island.

Genus **SCHIZOTRACHELUS** Lacordaire: 48, p. 454, 1866
(Type, *Schizotrachelus madens* Lacordaire)

Schizotrachelus altilis Kleine: 36, p. 227, 1922; 42, p. 64, 1927.
Solomons.

Schizotrachelus castaneicolor Kleine: 46, p. 326, 1933.
Fiji: Labasa.

Schizotrachelus salomonensis Kleine: 46, p. 326, 1933.
Solomons: Sofola.

Genus **CACOSCHIZUS** Sharp: 77, p. 386, 1900
(Type, *Cacoschizus schmeltzi* Fairmaire)

Cacoschizus schmeltzi Fairmaire: 12, p. 421, figs. 7, 7a, 7b, 1881; 15, p. 44, 1883; 51, p. 956, 1889; 8, p. cccix, 1895; 77, p. 386, 1900; 60, p. 39, 1910 (sub *Schizotrachelus*); 42, p. 65, 1927.
Solomons: Bougainville. Bismarck Archipelago: Gazelle Island; New Britain; Duke of York.

IX. BRENTHINI

Genus **BRENTHUS** Fabricius: 9, p. 95, 1787
(Type, *Brenthus anchorago* Linnaeus)

Brenthus efferatus Kleine: 43, p. 488, 1927; 42, p. 76, 1927.
Marquesas: Nukuhiva.

GENERA SEDIS INCERTAE

Genus **BOTRIORRHINUS** Fairmaire: 12, p. 421, 1881
(Type, *Botriorrhinus costulipennis* Fairmaire.)

Botriorrhinus costulipennis Fairmaire: 12, p. 421, 1881; 15, p. 42, 1883; 51, p. 956, 1889; 8, p. cccv, 1895; 60, p. 18, 1910; 42, p. 77, 1927.
Bismarck Archipelago: Duke of York.

Genus **DIASTROPHUS** Perroud: 57, p. 141, 1864
(Type, *Diastrophus planitarsus* Perroud)

Diastrophus planitarsus Perroud: 57, p. 142, 1884; 60, p. 19, 1910; 23, p. 259, 1916; 42, p. 77, 1927.
New Caledonia: Canala.

SPECIES SEDIS INCERTAE

chevrolati Boisduval: 2, p. 313, 1835; 18, p. 2720, 1872 (*Leptorrhynchus*); 60, p. 44, 1910 (*Ithystenus*); 42, p. 78, 1927 (sed. inc.).
Bismarck Archipelago: Woodlark Island. Solomons: Vanikoro; Santa Cruz.

debilis Sharp: 77, p. 387, pl. 35, fig. 9, 1900; 60, p. 44, 1910 (*Ithystenus*); 42, p. 78, 1927 (sed. inc.).
Bismarck Archipelago: New Britain.

pumilus Boisduval: 2, p. 314, pl. 7, fig. 24, 1835; 18, p. 2720, 1872 (*Leptorrhynchus*); 60, p. 44, 1910 (*Ithystenus*).
Bismarck Archipelago: New Britain.

unicolor Montrouzier: 52, p. 37, 1855; 60, p. 39, 1910 (*Schizotrachelus*).
New Caledonia.

victoris Perroud: 57, p. 137, 1864; 56, p. 92, 1854; 18, p. 2706, 1872; 23, p. 259, 1916; 60, p. 14, 1910 (*Trachelizus*); 42, p. 78, 1927, (sed. inc.).
New Caledonia: Canala.

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ATYIDAE OF SOUTHERN POLYNESIA

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BERNICE P. BISHOP MUSEUM

OCCASIONAL PAPERS

VOLUME XI, NUMBER 3

HONOLULU, HAWAII

PUBLISHED BY THE MUSEUM

May 15, 1935

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No adequate survey of the fresh-water crustacean fauna of southern Polynesia has yet been made. The immense area from Fiji and Samoa on the west to the Marquesas, Mangareva, and Pitcairn on the east includes many islands, most of which are low, without permanent streams or rivers and incapable of maintaining a fresh-water fauna. The few high islands of this intervening area, interspersed among the Cook, the Society, and the Austral archipelagoes, although two degrees of longitude distant from Fiji and Samoa, doubtless served as stepping stones in the eastern migrations of fresh-water organisms whether the dispersal was brought about through human agencies or otherwise. A thorough study of the aquatic fauna of the high islands between Fiji and the Marquesas would doubtless bring to light zoogeographical relationships of even greater interest than those now known for that area.

A few early collections of fresh-water crustaceans were taken from Fiji, Samoa, and Tahiti, but until recent years the aquatic fauna of the Marquesas and southeastern Polynesia was quite unknown. From our inadequate knowledge at the present time it seems certain that the fresh-water crustacean fauna moved from west to east through southern Polynesia. How this fauna, quite incapable of self-dispersal, succeeded in making its way from the western to the extreme eastern border of Polynesia is not yet clear.

During 1929 and 1930 A. M. Adamson made a collection of fresh-water prawns from several islands of the Marquesas. In 1933 I made a brief survey of the crustacean fauna of the fresh waters of Vitilevu and Tahiti. Harry S. Ladd in 1926 collected a few prawns in Vitilevu and in 1934 took a new species in the islands of Namuka and Wangava of the southern Lau Islands. The Mangarevan Expedition of Bernice P. Bishop Museum in 1934 secured specimens of fresh water crustaceans in Mangareva, Rapa, and Raivavae, extending the knowledge of their distribution into southeastern Polynesia. This brief report is concerned with the distribution of the family Atyidae from Fiji eastward through southern Polynesia.

The fauna of Fiji is of interest to the student of Polynesian zoogeography in that this archipelago represents a natural gateway for migrations from the East Indian region into Polynesia proper. The large size of some of the islands of Fiji, the heavy rainfall, and the numerous rivers and streams make a favorable habitat for a large and varied population of fresh-water prawns. Fiji is deserving of a more complete survey of its inland waters than it has yet received.

Mesocaris lauensis Edmondson.

Mesocaris lauensis Edmondson (8, p. 13, fig. 4).*

A small atyid collected by H. S. Ladd from a cave containing brackish water on the island of Namuka and also from a salty lake on the island of Wangava, both of the southern Lau Islands, described by Edmondson under a new genus. The species, which shows an adaptation to cavernicolous existence in the modification of the eye stalks and in the reduction of ocular pigment, is characterized by the presence of exopods on all the thoracic appendages and by seven pairs of gills.

This is the first record of one of the more primitive atyids in Polynesia. Geographically, the nearest relative of this species seems to be a representative of the genus *Paratya* (*Xiphocaridina*) known to inhabit Norfolk Island.

Caridina nilotica variety **brachydactyla** de Man. (fig. 1, *a-f*).

Caridina wyckii de Man (11, p. 386, part, pl. 24, fig. 29, *cc, dd, f, g, i, ii, k*).

Caridina wyckii variety *paucipara* Bouvier (3, p. 79, part).

Caradina nilotica variety *brachydactyla* de Man (12, p. 269, pl. 20, fig. 8).

Caridina brachydactyla Bouvier (5, p. 463).

Caridina nilotica variety *brachydactyla* Bouvier (6, p. 155, figs. 321, 322).

This variety is one of 13 recognized by Bouvier (6) and differs from the typical form in the relatively short dactyli of the last three legs. In the first walking leg the dactylus is less than one fifth the length of the propodus. The carpus of the first chelipod is slender, from 2.1 to 2.5 times as long as broad. In each of the three posterior legs the merus is armed with 3 spines.

Among the specimens collected a wide variation was seen in the number of teeth of the rostrum and some difference in the number of spinelets on the

* Numbers in parentheses refer to the bibliography, p. 19

dorsal surface of the telson and the hairs on its posterior margin. In 19 specimens observed the formula of the rostral teeth varied from $\frac{22}{18}$ to $\frac{34}{35}$. The largest specimen was taken at Vunindawa and measured 42 mm in length.

In a specimen from Suva (fig. 1, *a-f*) the rostral formula is $\frac{28}{18}$ with two teeth near the distal extremity of the upper border. The hand of the first cheliped is slightly longer than the corresponding carpus while in the second cheliped the carpus slightly exceeds the hand in length. Six spines are borne on the border of the dactylus of the third leg and the hairs on the dactylus of the fifth leg are very numerous. The dorsal surface of the telson bears 5 pairs of spinelets and there are 6 long hairs on its posterior border. The total length of this specimen, from tip of rostrum to extremity of telson is 25 mm.

The variety was taken in Vitilevu near Vunindawa and also in Suva from a small stream running through the garden of Dr. H. W. Simmonds. It was well represented in number of specimens in each locality.

This variety has previously been recognized in Madagascar, Mauritius, Poulo Condor, Salayer, New Caledonia, and the Marianas.

Caridina nilotica variety **brachydactyla** form **peninsularis** Kemp (fig. 1, *g-k*; fig. 4, *i-j*).

Caridina brachydactyla subspecies *peninsularis* Kemp (10, pp. 279-282, fig. 10); Bouvier (6, p. 156).

Kemp described this form as a subspecies of *Caridina brachydactyla* but since the term *brachydactyla* now represents a variety of *Caridina nilotica* I have reduced the subspecific name *peninsularis* to a form of the variety.

Kemp's *peninsularis* is characterized primarily by numerous teeth on the upper border of the rostrum arranged in a continuous series extending to the distal extremity.

A specimen taken near 8-mile Point near Suva in 1933 seems to correspond closely to Kemp's description of *peninsularis*. The rostral teeth are numerous with an uninterrupted series on the upper border, the formula being $\frac{37}{15}$. The chelipeds are quite similar to the corresponding appendages in the variety *brachydactyla*. Five spines are borne on the border of the short dactylus of the third leg. In this specimen the fifth legs are both damaged. The telson bears 3 pairs of spinelets on the dorsal border and 6 long hairs on the posterior margin. Uropodal spines number 14 on the left side and 15 on the right side.

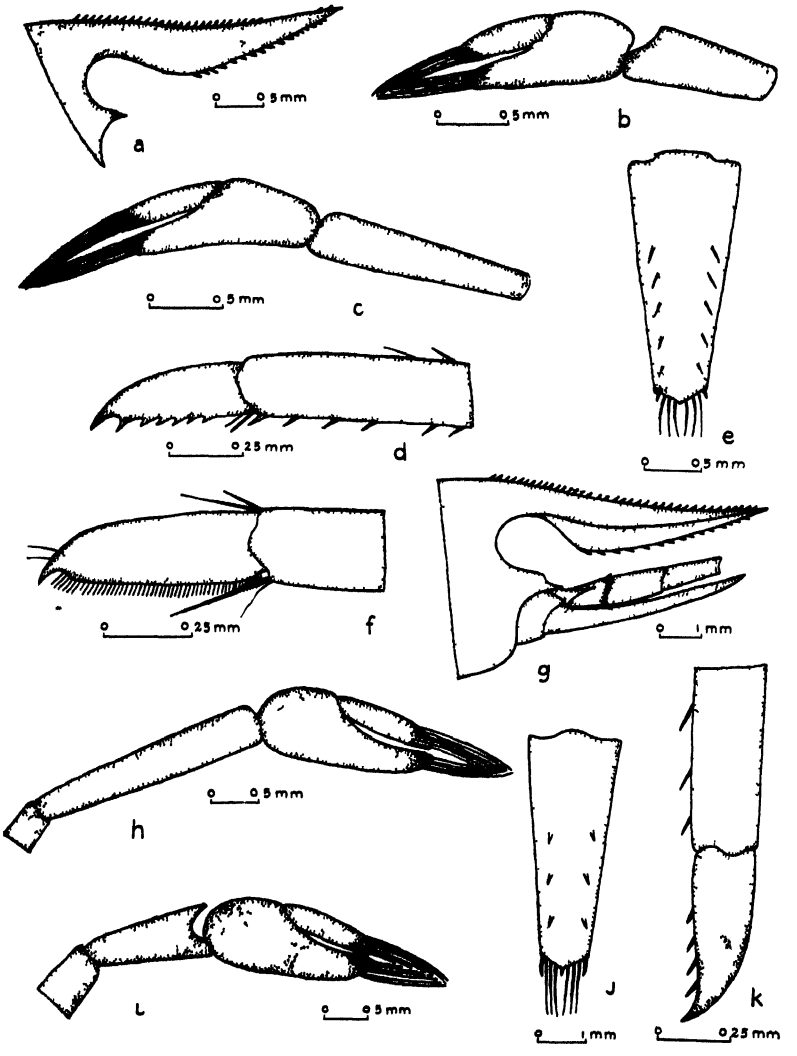

FIGURE 1—*Caridina nilotica* variety *brachydactyla* (*a-f*) and *Caridina nilotica* variety *brachydactyla* form *peninsularis* (*g-k*) *a*, rostrum, *b*, manus and carpus of first cheliped, *c*, manus and carpus of second cheliped, *d*, dactylus of third leg, *e*, telson, *f*, dactylus of fifth leg, *g* rostrum and anterior border of carapace, *h*, manus and carpus of second cheliped, *i*, manus and carpus of first cheliped, *j*, telson, *k*, dactylus of third leg

In addition to the specimen taken at 8-mile Point, which has a total length of 31 mm, a larger specimen 36 mm long collected at Vunindawa has been tentatively assigned to this form. (See fig. 4, *i, j.*) The teeth on the upper border of the rostrum number 31 forming a continuous series while there are 14 on the lower border. There are numerous hairs on the margin of the dactylus of the fifth leg.

Kemp's specimens were taken from near Patani, Siamese Malay States, and on Penang Island.

Caridina nilotica variety **wyckii** (Hickson).

Atya wyckii Hickson (9, p. 357, pls. 13, 14).

Caridina wyckii Borradaile (2, p. 1003); Roux (17, p. 554); Bouvier (3, p. 79, part).

Caridina nilotica variety *wyckii* de Man (12, p. 269); Bouvier (6, p. 151).

Borradaile records this variety from the Tamavria River, Suva, and states that it differs from varieties *longirostris* and *minahassa* in the short dactyli of the three posterior legs, that of the fifth leg being one fourth the length of the propodus. The formula of the rostral teeth of Borradaile's specimen is given as $\frac{19}{11}$. The variety was previously known from the Celebes. It was not taken in Fiji in 1933.

Caridina vitiensis Borradaile.

Caradina vitiensis Borradaile (2, p. 1003, pl. 63, fig. 3, 3*a*).

Caridina vitiensis Bouvier (3, p. 74; 4, p. 918; 5, p. 462; 6, p. 160, figs. 336-340).

According to Borradaile the species is characterized by a straight rostrum with 24 teeth above, none being on the carapace, and 9 below. The type specimen was 22 mm long. Borradaile considered it close to *Caridina weberi* but there are more rostral teeth, the second chelipeds are stouter and the last two legs longer than in that species.

The type locality was Tamavria River, Suva. It was not taken in 1933. Additional records of distribution include New Guinea, Bismarck Archipelago, and Solomon Islands.

Caridina brevicarpalis de Man (fig. 2, *a-f*).

Caridina brevicarpalis de Man (11) p. 397, pl. 24, fig. 30 *a-e*; Roux (17) p. 553; Bouvier (4) p. 919; Bouvier (5) p. 463; Bouvier (6) pp. 178-180, figs. 372-374.

The chief characteristic of this species is the short carpus of the first cheliped. In this feature the species resembles an atyid. The distal extremity of the upper border of the rostrum is free from teeth and the hairs or spinelets on the border of the dactylus of the fifth leg are few in number. The uropodal spines range from about 10 to 13.

Among the specimens collected the typical one (fig. 2) has 18 teeth on the upper border of the rostrum and 7 below. There are 4 spinelets on the border of the dactylus of the third leg, 13 on the border of the dactylus of the fifth leg. Five pairs of spinelets are borne on the dorsal surface of the telson and 6 long hairs on its posterior margin. In each of these features some variation exists among the specimens observed.

In 1933 the species was collected only at Vunindawa, Vitilevu, where it was relatively common, 11 specimens being obtained. Previous records are from Celebes, Flores, and Amboina.

Caridina serratirostris variety **typica** de Man (fig. 2, *g-l*).

Caridina serratirostris variety *typica* de Man (11, p. 385, pl. 23, fig. 28, *a-e*); Bouvier (6, pp. 219-220, figs. 480-486).

In this species the rostral teeth of the upper border extend backward on the carapace for nearly half its length. The chelipeds are very slender and there are few spinelets on the border of the dactylus of the fifth leg. Numerous hairs are borne on the posterior margin of the telson and the uropodal spines number about 14.

The larger of the two specimens collected is 18 mm long, the smaller 16 mm long. In the specimen figured (fig. 2) the formula of the rostral teeth is $\frac{23}{7}$ with 11 teeth behind the orbit. In each of the slender chelipeds the carpus exceeds the hand in length, that of the first only slightly. There are 4 teeth on the border of the dactylus of the third leg and 10 spinelets on the border of the dactylus of the fifth leg. Four pairs of spinelets are borne on the dorsal surface of the telson and 11 long hairs on its posterior margin.

Two ovigerous females were taken at Vunindawa, Vitilevu, in 1933. The variety *typica* has been previously recorded from the Seychelles, Salayer, Flores, and Ternate. Another variety, *celebensis*, was described from the Celebes by de Man (11).

Caridina weberi de Man (fig. 3, *a-f*; fig. 4, *g, h*).

Caridina weberi de Man (11, p. 371, pl. 21, fig. 23); Bouvier (6, p. 242, figs. 562-571).

The six varieties of this species recognized by Bouvier are distinguished chiefly by the characters of the rostrum, the walking legs, and the telson. The form of the rostrum and the number of rostral teeth vary greatly. Numerous short hairs border the dactylus of the fifth leg and usually 10 to 13 long hairs are carried on the posterior margin of the telson. Uropodal spines usually number from 19 to 22.

Specimens assigned to this species, variety *typica,* were taken in 1933 at 8-mile Point and Vunindawa, Vitilevu. They were not common at either locality. The specimen figured (fig. 3) has a nearly straight rostrum with 12 teeth above and 4 below. The hand of the

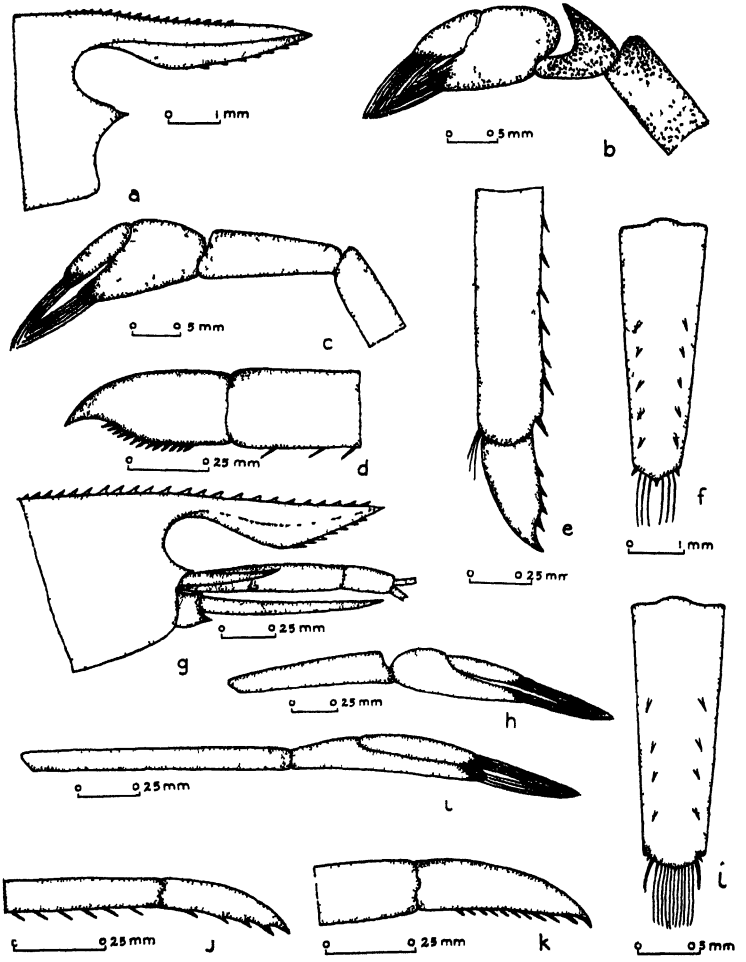

FIGURE 2.—*Caridina brevicarpalis* (*a-f*) and *Caridina serratirostris* (*g-l*): *a*, rostrum and anterior border of carapace; *b*, manus and carpus, first cheliped; *c*, manus and carpus, second cheliped; *d*, dactylus, fifth leg; *e*, dactylus, third leg; *f*, telson; *g*, rostrum and anterior border of carapace; *h*, manus and carpus, first cheliped; *i*, manus and carpus, second cheliped; *j*, dactylus, third leg; *k*, dactylus, fifth leg; *l*, telson.

first cheliped slightly exceeds the carpus in length while in the second cheliped the carpus is longer than the hand. Ten long hairs are carried on the posterior margin of the telson, the lateral ones being stouter than the others.

During a survey of fresh-water Crustacea in Tahiti in 1933 I secured numerous specimens of a form which corresponds closely with *Caridina weberi.* In most of these specimens the rostrum is slightly curved down and the teeth both above and below show considerable variation in number. (See fig. 4, *g.*) This form seems to be the prevailing species of *Caridina,* if not the only one, in Tahiti.

Specimens collected in the Marquesas by the Pacific Entomological Survey have also been assigned by me to the species *Caridina weberi.* These differ in formation of rostrum from those of Tahiti and Fiji more closely resembling varieties *sumatrensis* or *parvirostris* in which the rostrum is distinctly bent down. In a typical specimen from the Marquesas the tooth formula of the rostrum is $\frac{14}{2}$. (See fig. 4, *h.*)

Previous distribution of the species included Sumatra, Java, Salayer, Celebes, and Flores. This should now be extended to Fiji, Tahiti, and the Marquesas.

Caridina typus Milne-Edwards (fig. 3, *g-l*).

Caridina typus Milne-Edwards (14) vol. 2, p. 363, vol. 4, pl. 25, figs. 4, 5; de Man (11) p. 367, pl. 21, fig. 22; Bouvier (6) p. 249, figs. 271-297.

The chief characteristic of this species is the absence of teeth on the upper border of the rostrum. Uropodal spines are numerous, usually 19 or 20.

A typical specimen (fig. 3) has a rostrum gradually curved downward and reaching to the distal extremity of the second segment of the antennular peduncle. A single tooth is borne on the ventral border of the rostrum. The hand of the first cheliped is slightly longer than the carpus while in the second cheliped the hand and carpus are approximately equal in length. Seven spinelets are on the border of the dactylus of the third leg and the short hairs on the border of the dactylus of the fifth leg are numerous. There are numerous spinelets on the dorsal border of the rostrum and 10 long hairs on its posterior margin in addition to 2 stout spinelets.

Seven specimens were taken at 8-Mile Point near Suva in 1933. The range of the species is extensive. Previous records are from Madagascar and other high islands of the Indian Ocean, numerous islands of the East Indian region, Siam, the Loo-choo and Bonin islands, the Marianas, and New Caledonia.

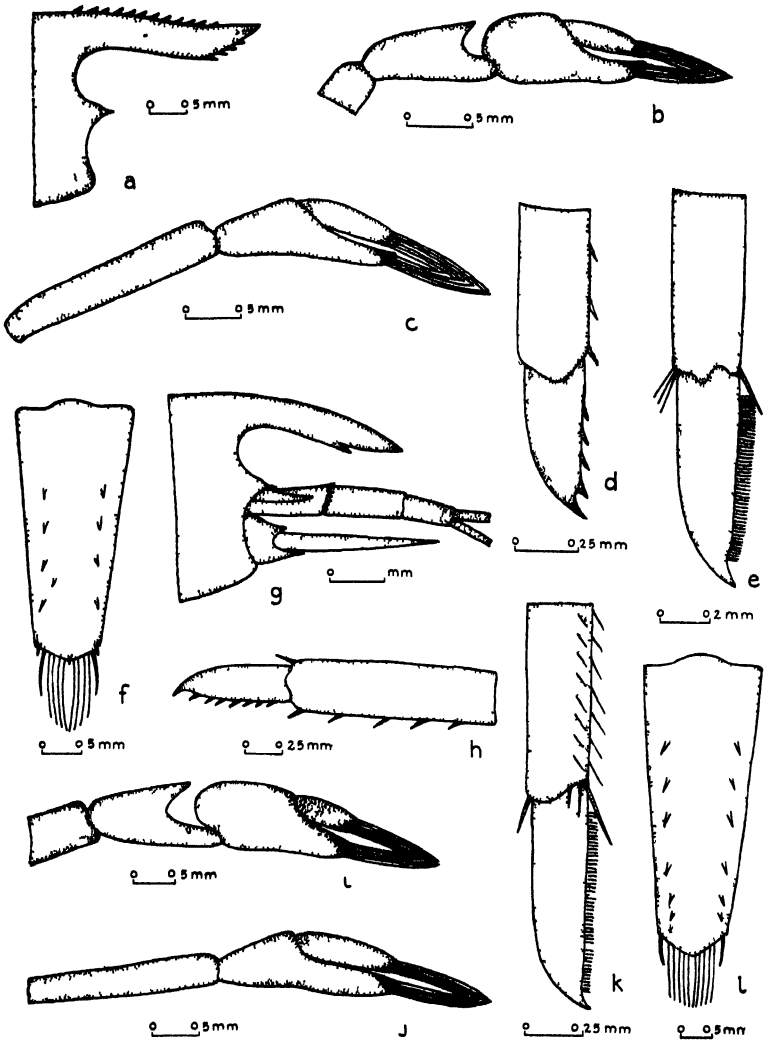

FIGURE 3—*Caridina weberi* (*a-f*) and *Caridina typus* (*g-l*) *a*, rostrum and anterior border of carapace, *b*, manus and carpus first cheliped, *c* manus and carpus, second cheliped, *d*, dactylus, third leg, *e*, dactylus fifth leg, *f*, telson, *g* rostrum and anterior border of carapace, *h*, dactylus, third leg, *i* manus and carpus, first cheliped, *j*, manus and carpus, second cheliped, *k* dactylus, fifth leg, *l* telson

Caridina species (fig. 4, *a-f*).

Rostrum slender, almost straight, reaching to the distal extremity of the second segment of the antennular peduncle; rostral tooth formula in 6 specimens $\frac{10}{4}, \frac{13}{5}, \frac{16}{7}, \frac{17}{6}, \frac{18}{6}, \frac{19}{6}$; from 1 to 4 teeth of upper border behind the orbit; teeth of lower border minute obscure notches. Suborbital spine of carapace prominent; pterygostomian angle rounded.

Lateral spine of first segment of antennular peduncle slender, not reaching to the distal extremity of the segment. Scale of the antenna outreaching the peduncle of the antennule.

Carpus of first cheliped shorter than manus, deeply excavated; carpus of second cheliped slightly longer than manus. Border of dactylus of third leg bearing 4 spines; dactylus of fifth leg slender, slightly curved, bordered by about 40 spinelets. Telson with 5 pairs of spinelets on dorsal surface and 8 long hairs on posterior margin. Uropodal spines 13 in number.

Sixteen small specimens were taken at 8-Mile Point near Suva in 1933. The largest, an ovigerous female, is 19 mm in length from tip of rostrum to extremity of telson. Eggs large, 1.1 mm in length. Bishop Museum collections no. 3932.

Although this doubtful form of *Caridina* bears some resemblance to *C. weberi,* the small number of rostral spines would exclude it from that species. The number and position of the rostral teeth separate it from *C. vitiensis* Borradaile.

Caridina rapaensis, new species (fig. 5, *a-h*).

Rostrum slender, slightly turned down, reaching to the middle of the second segment of the antennular peduncle. Rostral teeth small and few, stronger above than below, those above occupying the distal fourth of the border, the first (basal) tooth below is posterior to the first one of the upper border; tooth formula of rostrum $\frac{4}{4}$ in type specimen. Suborbital spine with a broad base; pterygostomian angle rounded. Basal segment of antennule concave dorsally; second segment shorter than the first; third segment subequal in length with the second, a transverse crest of spinelets at the distal extremity of the first segment; lateral spine of basal segment reaching to the extremity of that segment; a dense fringe of long feathered hairs on the ventrolateral borders of second and third segments; flagella long. Basal segment of antenna short; scale exceeding in length the peduncle of the antenule, a broad, blunt tooth on its outer margin; peduncle of flagellum about one half the length of the scale; flagellum long.

Eyes large, the cornea occupying more than one half the exposed portion. First cheliped reaching to distal extremity of basal segment of antennular peduncle when extended forward; propodus longer than carpus; dactylus as long as upper border of palm. Carpus deeply excavated. Second cheliped reaching to distal extremity of scale of antenna, more slender than first cheliped; propodus and carpus subequal in length.

Dactylus of third leg one sixth the length of the propodus, its border provided with a stout tooth just proximal of the tip, and four other small spines.

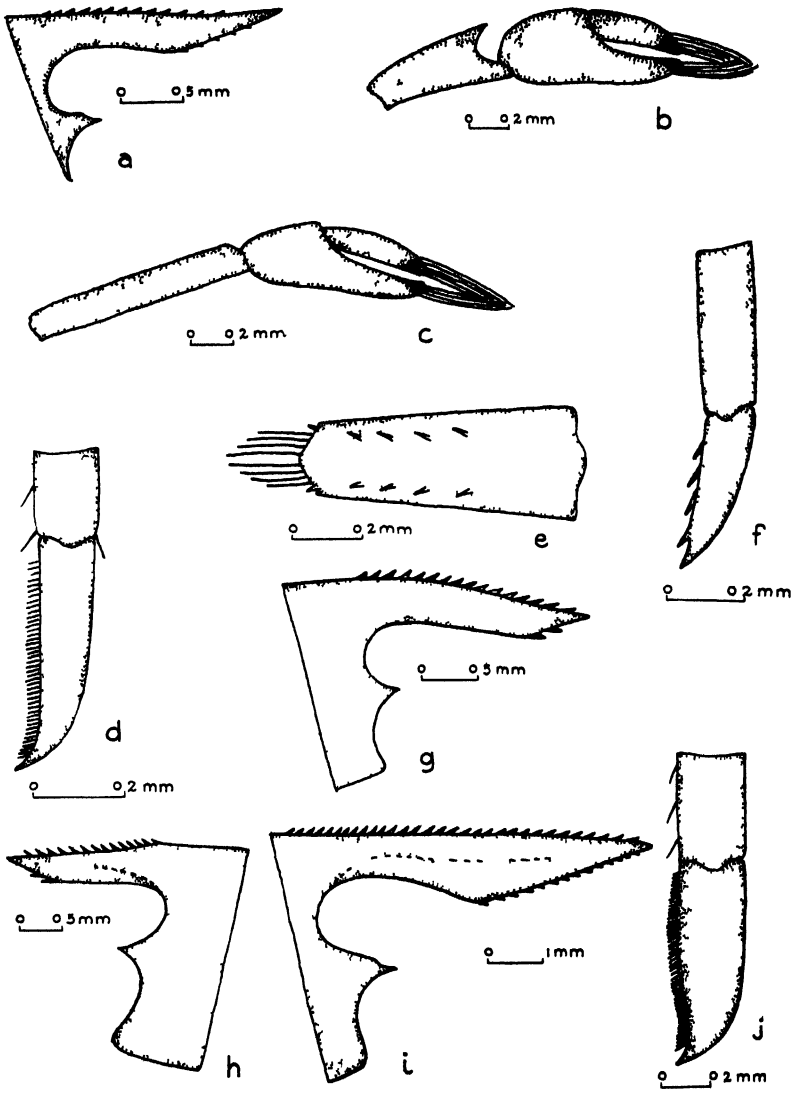

FIGURE 4—*Caridina* species (*a-f*), *Caridina weberi* (*g-h*) and *Caridina nilotica* variety *branchydactyla* form *peninsularis* (*i-j*) (?) *a*, rostrum, *b*, manus and carpus, first cheliped, *b* manus and carpus, second cheliped, *d*, dactylus, fifth leg, *e*, telson, *f*, dactylus, third leg, *g*, rostrum of specimen from Tahiti, *h*, rostrum of specimen from Marquesas, *i*, rostrum of specimen from Vunindawa, Vitilevu, *j*, dactylus of fifth leg of same specimen

Dactylus of fifth leg approximately one fifth the length of the propodus, its margin bearing numerous short hairs and a strong supplementary tooth near the tip.

Telson with 6 pairs of small spinelets on upper border, its posterior margin bearing a small median tooth, 9 feathered hairs, and a long slender spinelet at each lateral angle. Uropodal spinelets are 20 in number.

Type specimen a female, length 19 mm from tip of rostrum to extremity of telson. Specimens preserved in alcohol without color except a reddish tint of the carapace and some of the appendages of the head; cornea of eye black.

Type locality a fresh-water stream, Rapa. Type, Bishop Museum collections no. 3932.

The three specimens of the genus *Caridina* collected by the Mangarevan Expedition of 1934 on Rapa in southeastern Polynesia apparently represent this unrecorded species. Previously the genus was recognized in eastern Polynesia only from Tahiti and the Marquesas.

The numerous uropodal spinelets bring this species near *Caridina weberi,* which ranges into eastern Polynesia, being reported in Tahiti and the Marquesas. The species from Rapa differs from *C. weberi,* however, in the fewer rostral spines and their position, in the shorter carpus of the first cheliped, and the biunguiculate character of the dactyli of the third, fourth, and fifth legs.

The two cotypes, both females, present variations in the rostral tooth formula from the type specimen. In one the formula is $\frac{4}{4}$ the other $\frac{1}{3}$, the latter showing injury to the upper margin of the rostrum.

Atya serrata Spence Bate (fig. 5, *i*).

Atya serrata Bate (1, p. 699, pl. 119, fig. 2, part).

Atya brevirostris de Man (11, p. 360, pl. 21, fig. 21).

Atya serrata Bouvier (6, pp. 294-297, figs. 611-615, and synonymy).

In *Atya serrata* the short rostrum curves downward and is unarmed or provided with a few small teeth below. The supraorbital border of the carapace is salient and the anteroventral border rounded. The species bears some resemblance to an endemic species of Hawaii, *Atya bisulcata* (Randall), which, however, has a relatively long, straight rostrum usually unarmed but sometimes with one or two teeth close to the tip on the upper or lower margins. Another distinction between *Atya serrata* and *A. bisulcata* is in the anteroventral border of the carapace which, in *A. bisulcata* is drawn out into a sharp spine.

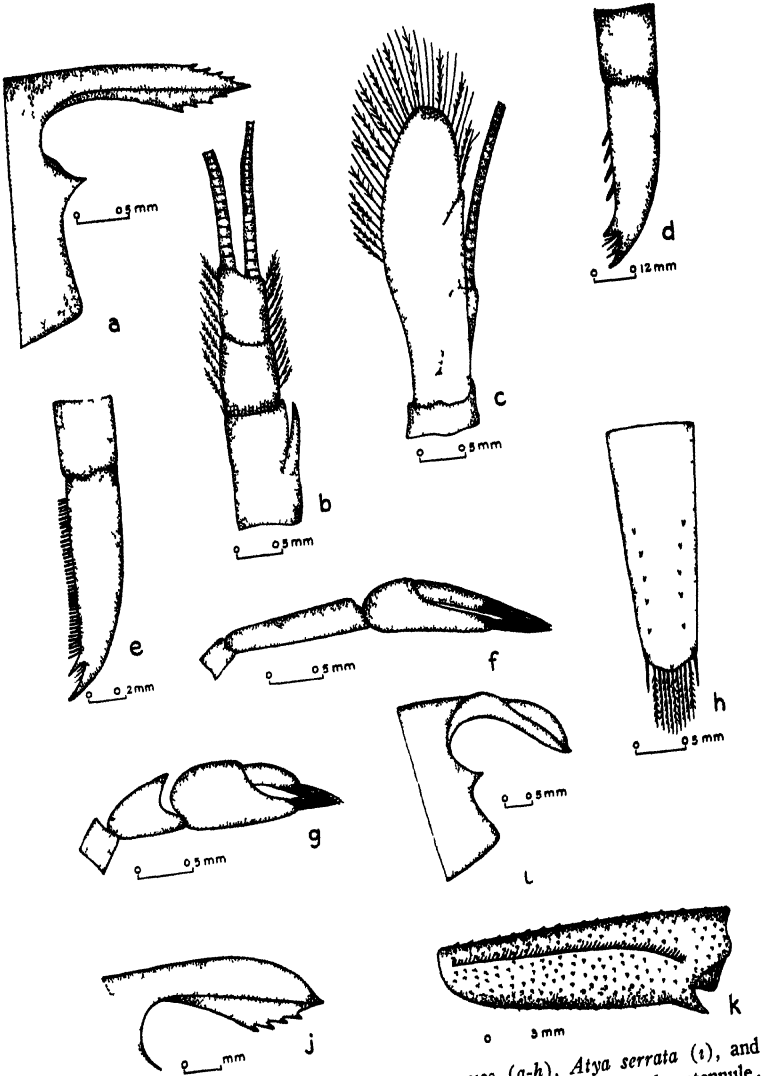

FIGURE 5—*Caridina rapaensis*, new species (*a-h*), *Atya serrata* (*i*), and *Atya spinifera* (*j-k*) *a*, rostrum and anterior border of carapace, *b*, antennule, *c* antenna, *d* dactylus, third leg, *e*, dactylus, fifth leg, *f*, manus and carpus, second cheliped, *g* manus and carpus, first cheliped, *h*, telson, *i*, rostrum and anterior border of carapace, *j* rostrum, *k*, merus of third leg

The range of *Atya serrata* is very extensive. There are records from Liberia, West Africa, and it is a typical species throughout the high islands of tropical latitudes in the Indian Ocean and has been reported from numerous localities in the East Indian archipelago.

In the Pacific Ocean the species is known from the Marianas, the Solomon Islands, Fiji, Samoa, and eastern Polynesia, including Tahiti, Marquesas, Mangareva, and Rapa. Its range into southeastern Polynesia (Mangareva and Rapa) was determined by collections taken by the Mangarevan Expedition of Bernice P. Bishop Museum in 1934. Specimens were collected in the Marquesas in 1922 by Pére Delmas and more recently by the Pacific Entomological Survey, 1929-30. The species was recorded from Tahiti in 1860 by Stimpson, was collected there by Gaston Seurat in 1903 and 1905, and by me in 1933. Extensive collections from Tahiti and the Marquesas and limited ones from Mangareva and Rapa would suggest that *Atya serrata* is the sole representative of the genus throughout eastern Polynesia.

Atya spinipes Newport (fig. 5, *j, k*).

Atya spinipes Newport (15, pp. 159-160).

Atya spinipes and *A. pilipes* Miers (13, p. 382, pl. 15, figs. 5, 6).

Atya pilipes Ortmann (16, pp. 466-467, pl. 36, fig. 8).

Atya spinipes Bouvier (6, pp. 304-305).

This species is closely related to *Atya moluccensis* de Haan of the East Indian area. In *Atya spinipes* the rostrum is deep, entire above, curved downward, and abruptly pointed, its lower border toothed. The merus of the third leg is stout and in the male bears a strong spine at the distal extremity of the lower border. In the female the spine is more slender and is carried higher up on the lateral surface. In *Atya moluccensis* the rostrum is straighter, more pointed, and has less depth than that of *Atya spinipes*. The stout tooth of the merus of the third leg in the male of *Atya moluccensis* is borne nearer the middle of the segment.

Among specimens of *Atya spinipes* from Fiji in Bernice P. Bishop Museum is a male 75 mm long from tip of rostrum to extremity of telson.

In addition to the Philippines the species has been recorded from the Marianas Islands, Samoa, and Fiji. Ortmann recorded it from Fiji in 1890. Specimens were collected in Vitilevu by H. S. Ladd in 1926 and again in 1933 by me.

Zoea of Atyidae compared

Apparently few studies of the larvae of atyids have been made. It was pointed out by Edmondson (7) that *Atya bisulcata* (Randall) and *Ortmannia henshawi* Rathbun are identical species, the young of *Atya* being of the "Ortmannia" form some of which by the natural process of growth and successive molting are transformed into the "Atya" type. It was the observation of Edmondson that in aquaria without circulating water the eggs of *Atya* may hatch into the zoea stage but under a strong current the zoea is passed in the egg and the young is released as a mysis-like form.

While investigating the aquatic fauna in Vitilevu in 1933 and later in the same year in Tahiti I attempted to secure larval stages of some of the Atyidae collected. During the brief period spent in Fiji larvae in the zoea stage were obtained from but one species, *Caridina nilotica* variety *brachydactyla* form *peninsularis*. Better success attended efforts in Tahiti, where by confining ovigerous females in specially prepared containers under natural conditions in fresh-water streams, and also from laboratory-controlled specimens, large numbers of zoea were hatched from two Atyids, *Caridina weberi* and *Atya serrata*. By comparison there is seen a close similarity between the first zoea of different species of *Caridina,* of *Caridina* and *Atya,* and of two species of *Atya, Atya serrata* of Tahiti and *Atya bisulcata* of Hawaii.

In the zoea of both *Caridina* and *Atya* (fig. 6) three pairs of thoracic appendages are about equally developed and in front of these are two pairs of rudimentary appendages. In these biramous appendages the inner branch which is shorter than the outer is relatively longer in the posterior appendage. There are no marked differences between corresponding thoracic appendages of any of the larval forms observed. The telson of *Caridina nilotica* is longer and the posterior median notch is narrower and more acute than in *Caridina weberi.* In the median notch of the telson *Caridina weberi* closely resembles *Atya.* In all larval forms studied seven pairs of bristles are borne on the posterior border of the telson.

Between *Atya serrata* and *Atya bisulcata* but slight and insignificant differences can be detected in the early free-swimming stages. The telson of *Atya bisulcata* is a little longer but the sixth segment of the abdomen is slightly shorter than in *Atya serrata.* The antennules and antenna of the two species of *Caridina* compared show no

appreciable differences and the same may be said of the corresponding appendages of the two species of *Atya.* In *Atya,* however, there is a longer and stouter basal segment in the peduncle of the antennule than in *Caridina.*

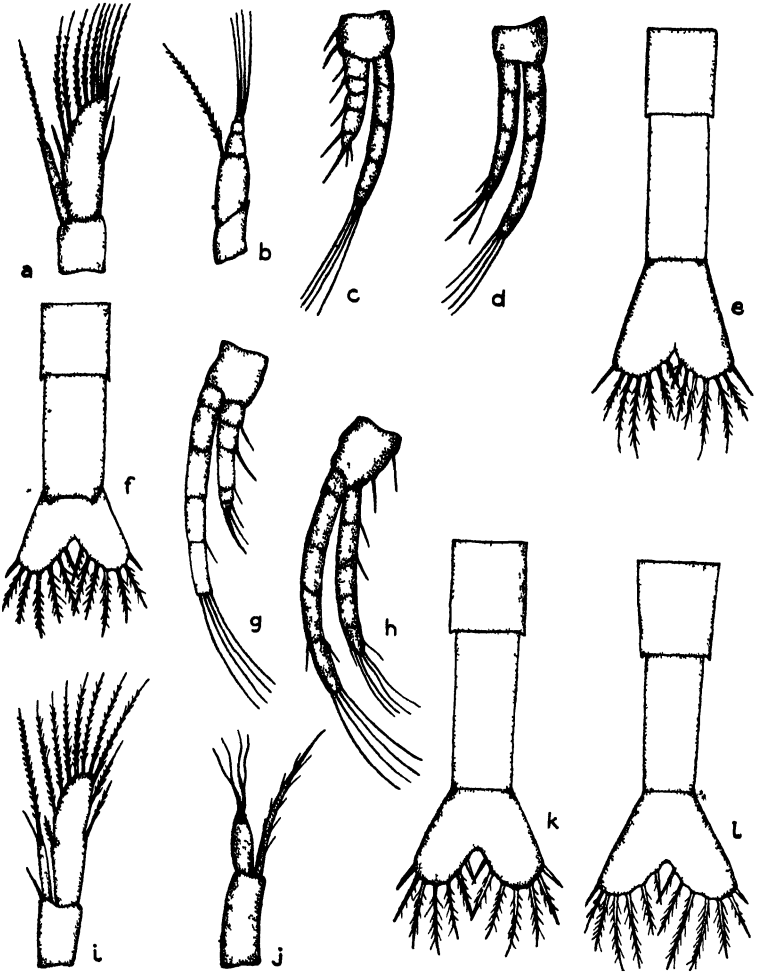

FIGURE 6—Larval stages of *Caridina* and *Atya. Caridina nilotica* variety *brachydactyla* form *peninsularis* (*a-e*); *Caridina weberi* (*f*); *Atya serrata* (*g-i, l*); *Atya bisulcata* (*j, k*): *a,* antenna; *b,* antennule; *c,* next to last thoracic appendage; *d,* last thoracic appendage; *e,* telson; *f,* telson; *g,* next to last thoracic appendage; *h,* last thoracic appendage; *i,* antenna; *j,* antennule; *k,* telson; *l,* telson. All greatly enlarged

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NEW PALMS FROM FIJI

By

MAX BURRET

BERNICE P. BISHOP MUSEUM

OCCASIONAL PAPERS

VOLUME XI, NUMBER 4

HONOLULU, HAWAII

PUBLISHED BY THE MUSEUM

May 25, 1935

NEW PALMS FROM FIJI

By MAX BURRET

Most of the plants described in this paper were collected by Dr. A. C. Smith in 1933 and 1934, with the aid of a Bishop Museum Fellowship in Yale University. The first set of specimens is deposited in the herbarium of Bernice P. Bishop Museum.

For convenience, one species from Samoa is described here.

Genus PRITCHARDIA Seemann and H. Wendland

Pritchardia thurstoni F. von Mueller and Drude.

Fiji: Fulanga, A. C. Smith 1230, on limestone cliff in lagoon. Local names are *masai* and *viu*. The species is very common on the small islets in the lagoon; it has previously been collected only once in a wild state.

Genus EXORRHIZA Beccari

Exorrhiza smithii, species nova.

Palma 4-8 m alta; caudex robustus curvatus annulatus; frondis vagina cylindrica, ad apicem extus fusco-leproso-maculata; petiolus evolutus, inter minores, visum fragmentum inferius 20 cm longum, ad basin 4 cm, superne 2.5 cm in diam. metiens, marginibus acutis, supra concavus, subtus rotundato-triangularis, in modo jam descripto fusco-maculatus; segmenta numerosa, regulariter disposita, directione haud variantia, a rhachi sat patentia sed superne cernua, sat robusta, linearia, haud curvata, maxima visa 62 cm longa, 2.4 cm lata, basi leviter reduplicata, superne sensim attenuata et acuminata, longe anguste producta, in apices 2 perangustos profunde fissa, 3-nervia, costa media et nervo secundario fere aequivalido dextra sinistra percursa, nervis tertiariis numerosis densis conspicuis, subtus iisdem nervis et tertiariis densis, prominentibus, squamulis minutis fuscis dense praeditis, costa media inferne paleis badiis linearibus in dimidia parte affixis notata; segmenta superiora sensim latitude et longitudine decrescentia, sensim longe anguste acuminata; spadix infra frondes, scopiformis, duplo-(forsan triplo?) ramosus; rami 2 visi ramulos floriferos 5 gerentes, applanati, breves; ramuli rhachi brevi inserti, basi bractea late ovata breviter subito acuminata suffulti, pro rata tenues, 20 cm circ. longi, i. s. longitudinaliter dense striati, glabri, apice in filum flexuosum sat longum producti; florum glomeruli in spira densa dispositi, in alveolis sat profundis; axis margine triangulariter nonnihil producto, superne curvato, acuto; glomeruli ad maximam ramorum partem 3-flori, bracteis conspicuis late ovatis, flore ♀ intermedio, ♂ binis superpositis, ad ramorum apicem floribus ♂ tantum; flores ♂ non visi, omnes delapsi, ♀ parvi, ovati; sepala ovata; petala ovata, apice breviter triangulari valvata; fructus ignoti.

Fiji: Vanua Levu, Thakaundrove, eastern buttress of Mount Ndikeva, altitude 900 meters, June 5, 1934, A. C. Smith 1879, type.

It is a species related to *E. wendlandiana* Beccari, but with the spadix much smaller, the branchlets much shorter and thinner, and the leaf segments straight rather than falcate. The segments of the new species are perhaps not so deeply split at the apex, and on the under surface bear more densely congested brown scales. I have not seen the male flowers of *E. smithii,* which are probably smaller than those of *E. wendlandiana.* The following new Samoan species is also of this alliance.

Exorrhiza vaupelii, species nova.

Frondis rhachis superne triangularis, in marginibus crispato-floccoso-fusco-tomentosa, in lateribus et subtus atro-leproso-punctulata; segmenta numerosa, regulariter disposita, directione haud variantia, majora visa 80 cm circ. longa, usque 3.4 cm lata, textura firma, basi modice, sed conspicue reduplicata, linearia, haud curvata, maxima latitudine in parte inferiore sita, dein sensim attenuata et longe anguste sensim acuminata, in apices 2 angustos aequales fissa, 3-nervia, costa media valde prominente, ad basin modo descripto fusco-tomentosa, subtus inferne paleis badiis linearibus numerosis densissimis notata, nervis lateralibus praecipue ad basin supra plicato-prominentibus, minus superne; nervi tertiarii numerosi, utrinque conspicui, subtus squamulis atris densis praediti; segmenta superiora longitudine et latitudine decrescentia.

Samoa: Savaii, south of Mangaloa, altitude 1200 meters, F. Vaupel 605, type, in Herb. Berlin.

E. vaupelii resembles *E. smithii* in its linear leaflets which are not at all curved, with very numerous minute dark scales on the lower surface. I have little doubt as to the proper genus; the only other genus to be compared is *Chinostigma. C. oncorhynchum* Beccari has not the dense minute scales on the under surface of the leaflets. I have not seen the leaflets of *C. samoense* H. Wendland, but the above-mentioned minute scales are apparently lacking, and the rachis is said to be quite glabrous. *C. powellianum,* from the description, is very close to *C. samoense.*

Genus VEITCHIA H. Wendland

Veitchia joannis H. Wendland.

Fiji: Vanua Levu, Thakaundrove, southern slope of Korotini Range, below Navitho Pass, 300-650 meters, A. C. Smith 575. In Seemann's "Flora Vitiensis" this palm is mentioned as being very common throughout Fiji. In the wet forest of Vanua Levu, however, it is rare, having been observed only twice by the collector. It appears to be the tallest palm of the region, the preesnt specimen being over 100 feet in height.

Genus **BALAKA** Beccari

Balaka longirostris Beccari.

Fiji, without exact locality, D. Jeoward, in 1894 (non vidi).

This palm has been described by Beccari only from fruits, without perianth. It has the largest fruit as yet known in the genus *Balaka.* The plant below described is possibly identical with *B. longirostris,* but from the description and figure of the fruit of that species, I believe the new species to be quite distinct. The fruits of *B. longirostris* are 32 mm long; the fruits of our new species are 40 mm and more long, having more excavate sides, the rostrum much broader, and the sclerosoms of the surface quite distinct, in which characters it differs from the description and figure of Beccari's species. The new species may be known as:

Balaka macrocarpa, species nova.

Palma 4-8 m alta, caudice gracili, 4-6 cm in diam. metiente; frondes ex fragmentis inter majores, circ. 2 m longae; vagina ut petiolus et rhachis fusco-furfuracea, demum minute fusco-leprosa, vagina cylindrica, robusta, dorso i. s. 6 mm in diam. metiens, fibris densis numerosis percursa, apice sat breviter contracta; petiolus 13 cm circ. longus, robustus, basi 1.2 cm, apice 1 cm fere latus, supra canaliculatus, marginibus acutis, dorso late angulato-rotundatus; segmenta prob. sat numerosa, infima ambo angusta, linearia, 8-15 mm lata, rhacheos prob. mediae 2 visa in margine superiore 38-41 cm longa, leviter sigmoidea, alterum nervis primariis 2 percursum, superne 10.5 cm latum, inferne sensim angustatum, ad basin 3.2 cm in diam., rhachin secus 6 cm latum, apice oblique lobulato-praemorsum, alterum costa media unica, ad apicem 7.2 cm latum, basi nonnihil angustiore, rhacheos fragmentum apicale summis segmentis ambobus latissimis, rhacheos 21.5-24.5 cm amplectentibus, apice ipso oblique praemorso, obtuse triangulariter lobulato, 17 cm lato, nervis primariis 8 percursis, segmento inferne sequente viso leviter cuneato, 35 cm longo, superne 4.5 cm lato, nervo primario uno percurso; spadix 3 dm circ. longus; rhacheos fragmentum ut rami ramulique i. s. sat acute longitudinaliter angulosi, densissime conspicue granulosi; rami primarii 2 visi, basi bractea brevi late rotundata suffulti, ramulis 2-3; ramuli fructiferi paulo curvati, ad fructuum insertiones modice flexuosi, inter robustiores, in dimidia circ. parte 2-2.5 mm in internodiis in diam. metientes, superne sensim angustati, visi 15-20 cm longi, fructibus spiraliter dispositis; ex insertionibus florum glomeruli ad magnam ramuli partem 3-flori, flore ♀ intermedio, ♂ binis dextra sinistra insertis, superne 2-flori, flore femineo et masculo juxtapositis, demum flore ♂ solitario; fructus basi bracteis erectis late rotundatis calyculum humilem, 1 mm altitudine paulo superantem formantibus cincti, magni, i. v. aurantiaci, i. s. brunneo-flavidi, 4.2 cm longi, quadrangulares, 1.5 cm in diam. metientes, angulis longitudinalibus acutis valde prominentibus, lateribus inter angulos nonnihil excavatis, pericarpii rugis perpaucis, sed plerumque prominentibus transverse vel plus minus oblique pertensis, rostrati; rostrum excentrice productum, crassum, angulariter conicum, 13 mm longum; perianthium cupuliforme, laxe accumbens;

calyx delapsus; corolla 12 mm alta, petalis late rotundatis, apice breviter triangulari haud producto, obsoleto, longitudinaliter dense nervoso-striatus; epicarpium sclerosomatibus densis lineolatis conspicuis; pericarpium carnosum, siccum pro rata sat evolutum; endocarpium pergamaceum; semen acute 4-angulare, 22 mm longum, 6-7 mm in diam. metiens, rostrum conspicue anguste acuminatum, 8-9 mm longum; raphe ab apice in angulo longe decurrens, ramis in quoque latere 4, dorso sat numerosis descendentibus, parce furcatis vel anastomosantibus; embryo basilaris; albumen aequabile; flores ♂ haud perfecte evoluti visi 5 mm longi, ovato-oblongi, fusco-leproso-maculati; calyx 2.5 mm altus, sepalis basi umbonatis, superne nervoso-striatis, apice late rotundatis, ciliatis; petala oblonga costata; stamina ∞ ; filamenta filiformia; antherae lineares, basi sagittatae, apice incisae, dorso ad basin affixae; pistillodium inferne dilatatum, superne in stylum productum, longitudine staminum.

Fiji: Vanua Levu, Thakaundrove, Natewa Peninsula, Uluingala, altitude 600-820 meters, June 15, 1934, A. C. Smith 2007, type.

This slender and attractive palm, known as *niuniu,* was seen only once. Several trees were growing close together in the shade of large forest trees, on a sharp well-drained slope.

Balaka cuneata, species nova.

Palma 2-5 m alta; caudex 1.5 cm circ. in diam., annulis, ut videtur, sat dissitis; frondis vagina fusco-furfuracea, in latere petiolo opposito producta; petiolus circ. 20 cm longus, sordide flavido-tomentosus atque fusco-lepidoto-leprosus; rhachis 65 cm fere longa, furfuracea et fusco-leprosa, segmentis utrinsecus 9; segmenta sat regulariter disposita, infimum cujusque lateris quam reliqua aliquanto minus, praecipue angustius, media circ. 23 cm longa, 7 cm lata, in margine superiore producta, margine superiore oblique lobulato-praemorso, apicalia confluentia, nervis primariis 3 percursa, rhacheos 4.3-5.5 cm amplectentia, in margine superiore 18 cm longa, 6-7 cm in diam., oblique lobulato-praemorsa, reliqua nervo primario unico percursa, omnia supra nitentia, glabra, subtus fere opaca, ad margines et in segmentis apicalibus ambobus ad nervos secundarios fusco-furfuracea, papyracea, cuneiformia, ad basin haud curvata, vix reduplicata, costa basin versus haud curvata; spadix 35 cm fere longus, duplicato-ramosus; pedunculus 13 cm longus, applanatus, decidue fusco-furfuraceus, spathe inferioris annulo ad basin, superioris 3 cm altius sito atque bractea semiannulari 4 cm supra eum notatus; rhachis vix flexuosa, ramis primariis ramificatis 4 atque simplicibus reliquis 7, infimis 2 ramulos fructiferos 4 (secundo) vel plures (infimo), sequentibus 3-2 gerentibus; ramuli fructiferi majores usque 16 cm longi visi, plurimi breviores, omnes superne sensim attenuati, vix curvati, haud flexuosi; fructus ex glomerulis in spira perlaxe dispositis i. s. cum periantho 1.3 cm longi, usque 6 mm lati, oblique nonnihil rostrati, inferne 4-angulares, sclerosomatibus densissime gibbosi, nigri; perianthium sat explanatum, tenue; sepala late rotundata; petala lata, margine ciliata, longitudinaliter dense nervoso-striata, apice triangulari valvata.

Fiji: Vanua Levu, Thakaundrove, hills between Vatukawa and Wainingio Rivers, Ndrekeniwai Valley, altitude 200-500 meters, November 24, 1933, A. C. Smith 577, type; Natewa Peninsula, hills south of Natewa, altitude 400-600 meters, A. C. Smith 1950.

The species, locally known as *mbalaka,* is near *B. seemannii,* (H. Wendland) Beccari, from which it differs by the cuneate leaflets, which, with the costa, are not curved at the base. The spadix is much more ramified than that of *B. seemannii.* The other species of the genus known from Fiji have much shorter and broader deltoid leaflets. *B. longirostris* Beccari has fruits twice as long and thick.

Genus **VITIPHOENIX** Beccari

Subgenus 1. **EUVITIPHOENIX,** subgenus novum

Frondis segmenta apice praemorsa; bracteae florem ♀ et fructum cingentes explanatae angustissimae obsoletae.

This subgenus includes the following species: *V. filifera* (H. Wendland) Beccari, *V. viticnsis* (H. Wendland) Burret, *V. pickeringii* (H. Wendland) Burret, *V. pauciflora* (H. Wendland) Burret, and:

Vitiphoenix (Euvitiphoenix) smithii, species nova.

Palma 16 m alta; frondes 3 m longae; vaginae apex visus, extus ut petiolus et rhachis praecipue subtus cinereo- (an in vivo fusco)-tomentosus et minute dense vel sat dense fusco-lepidotus; petioli fragmentum a vagine apice 16.5 cm longum visum subtus rotundato-triangulare, marginibus acutis, supra marginem versus paulo excavatum, dimidium secus leviter convexum, basi 18 mm latum, ad apicem vix angustius; segmenta numerosa, regulariter disposita, maxima visa 41.5 cm longa, usque 5 cm lata, leviter sigmoidea, basin versus conspicue, superne leviter curvata, maxima latitudine ad dimidiam vel modice infra sita, inferne nonnihil fere contracto-angustata, ad basin angusta, 8 mm circ. lata, paulo sed conspicue reduplicata, superne nonnihil angustata, ad apicem oblique lobulato-praemorsum 1.8 cm tantum lata, supra nitentia, subtus opaca, sub lente saepe minutissime gibbosa, costa media unica, subtus basin versus paleis badiis linearibus densis praedita, nervis marginalibus validis, inferne subtus fusco-lepidoto-punctulatis, nervis minus validis sat numerosis, ulterioribus nullis; segmenta superiora sensim longitudine et latitudine decrescentia, fere rectilinearia, maxima latitudine in dimidia circ. sita, inferne nonnihil angustata, reduplicata sed etiam apicem versus conspicue angustata, apice oblique lobulato-praemorsa, apicalia ambo quam sequentia conspicue latiora, 2 cm circ. lata, 10 cm in margine superiore longa, apicem versus paulo attenuata, apice transverse lobulato-praemorsa; spadix infra frondes, 1 m longus, 4-plo multiramosus; rhachis et rami visi glabri; rhachis et rami primarii applanato-subtriangulares, rami (visi) basi bractea haud producta, anguste lineolata; ramus primarius maximus visus 30 cm longus; rami ramulique i. s. longitudinaliter lineolati, ramuli ultimae ordinis plurimi, breves et perbreves, pauciflori, longissimus visus 6.5 cm longus, majores 2.5 cm minores numerosi 1 cm vix aequantes, fructibus 2-1, omnes inter tenuiores, in internodiis 1 mm circ. in diam, metientes, superne attenuati, ad nodos leviter flexuosi; florum glomeruli inferiores 3-flori, ♀ medio, ♂ binis juxtapositis, ad apicem ramulorum 2 prob. masculi; fructum insertiones

obliqui, quam axis duplo latiores, bracteis explanatis; fructus i. s. cum perianthio 12 mm longus, ambitu clavato-oblongus, superne usque 7 mm in diam., apice haud producto, breviter conico, extus glabri, longitudinaliter dense fibroso-lineolati, sclerosomatibus nullis; perianthium fructiferum 6-7 mm altum, cupuliforme, ore 5-6 mm in diam. metiente; calyx scutelliformis, sepalis late rotundatis, nervoso-striatis; corolla 3-plo fere altior, petala nervoso-striata, late rotundata, imbricata, apice breviter triangulari valvata; mesocarpium fibris numerosis, endocarpium tenue; semen ambitu oblongum, leviter claviforme, teres, 11 mm longum, superne 5.5 mm in diam.; rhaphe linearis, totum latus sequens, ramis ex rhapheos parte superiore et dorso paralleliter descendentibus, parce anastomosantibus; embryo basilaris; albumen aequabile; staminodia in perianthii basi perpauca, visa 2-3 sat late dentiformia; flores ♂ nondum perfecte evoluti visi 4 mm longi, ambitu ovato-oblongi; calyx 2 mm altus, sepalis late rotundatis ciliatis; petala sat crassa; stamina numerosa, filamentum filiforme, demum prob. sat evolutum; antherae oblongo-lineares, basi sagittatae, apice incisae, dorso ad basin affixae; pistillodium inferne fusiforme, superne filiforme, longitudine staminum.

Fiji: Kandavu, hills above Namalata and Ngaloa Bays, altitude 200-400 meters, October 16, 1933, A. C. Smith 162, type.

V. smithii differs from the other known Fijian species, except *V. vitiensis,* which is described only from leaves, by having the spadix more branched, with the thin branchlets much shorter and with few fruits. The leaflets of the new species are conspicuously attenuate towards the apex, and the rachis is tomentose below in a very characteristic peculiar manner, whereas in *V. vitiensis* the superior leaflets do not taper towards the end, the rachis being only leprose rather than tomentose.

Subgenus 2. ACMOPHOENIX, subgenus novum

Frondis segmenta apice acuta; bracteae florem ♀ et fructum cingentes surgentes, conspicuae, calyculum formantes.

Although the following two species differ considerably from those of *Euvitiphoenix,* differences in the fruits, seeds, and flowers do not seem sufficient to necessitate a new genus.

Vitiphoenix (Acmophoenix) petiolata, species nova.

Palma 15-35 m alta; vagina ut petiolus et rhachis subtus furfuracea atque punctato-fusco-furfuracea; petiolus in fragmento ab apice vaginae 25 cm circ. longo visus, supra excavatus, marginibus acutis, subtus rotundato-trianglaris; segmenta infima jam sat dense sese sequentia, omnia regulariter disposita, prob. dimidiae circ. rhacheos lanceolata, 55 cm longa, 4 cm lata, maxima latitudine in tertia inferiore sita, inferne sensim angustata, basi sat angusta, leviter sed conspicue curvata, superne sensim attenuata et acuminata, inaequaliter bifida, apice superiore multo longiore, anguste, sat longe acuminato, inferiore brevi, textura rigida, costa media subtus basin versus paleis anguste linearibus, i. s.

tortis dense praedita, nervis marginalibus sat robustis, minus validis dextra sinistra pluribus, paulo conspicuis, tenuibus obscuris, segmenta superiora longitudine et latitudine decrescentia, lineari-lanceolata, superne attenuata, apice breviter bifida; spadix 3-plo ramosus, pedunculatus, rhachis, ut rami et ramuli inferne longitudinaliter angulosi, i. s. dense, ramuli superne minus dense gibbosi; rami primarii ramosi sat numerosi; ramuli floriferi 10-12 cm longi, in internodiis dimidiae partis i. s. 1.5 mm in diam., raro paulo crassiores, superne leviter flexuosi, usque ad apicem fere glomerulis in spira laxa dispositis, 3-floris, ♀ internodio, ad apicem tantum 2-floris, masculis ad summum apicem breviter fere filiformes; flores ♂ 7 mm circ. longi, oblongi; calyx i. s. patens, sat explanatus, 4 mm in diam. metiens, sepalis late rotundatis; petala oblonga; stamina numerosa, circ. 50; filamenta filiformia, quam antherae breviora; antherae lineares, 3 mm longitudine superantes, basi sagittatae, apice incisae, dorso basi affixae; pistillodium filiforme, apice bifidum, an semper?, longitudine fere staminum; bracteae florem ♀ cingentes surgentes, conspicuae; flos ♀ : sepala late rotundata, petala late rotundata, apice triangularia; fructus inter minores angustiores, cum perianthio i. s. 1.8 cm longus, 0.6 cm in diam. metiens, ambitu oblongo-lanceolatus, breviter sed conspicue rostratus, extus sclero-somatibus densissime sat longe lineolatus; pericarpium i. s. 0.5 mm in diam. vix superans; mesocarpium fibris numerosis percursum; endocarpium tenue; semen ambitu oblongo-lanceolatum, 1 cm fere longum, 4 mm in diam., teres, apice basique rotundatum; albumen aequabile; embryo basilaris; perianthium cupulare, 5 mm altum, 5 mm in diam.; calyx humilis, sepalis late rotundatis, extus nervosis; petala late rotundata, apice breviter triangulari sed tamen quam margines conspicue altiore; staminodia pauca, plus minus late dentiformia.

Fiji: Vanua Levu, Mbua, southern slope of Mount Seatura, altitude 500 meters, April 28, 1934, A. C. Smith 1687, type.

This palm, growing in dense wet forest, is one of those known as *niuniu*. Compared to *V. sessilifolia* (below described), the petiole in *V. petiolata* is quite conspicuous, the fruit is much smaller, narrower, and rostrate at the top, the calyx of the male flowers is patent and explanate, the triangular valvate top of the petals of the fruiting perianth is conspicuously longer than the margins, whereas the top of the petals in *V. sessilifolia* is shorter than the protracted margins.

Vitiphoenix (Acmophoenix) sessilifolia, species nova.

Palma 10 m alta; frondis vagina cylindrica, ut rhachis praecipue subtus punctulato-fusco-leprosa atque plus minus decidue furfuracea; frondes quam homo adultus modice longiores, superne cernuae, segmentis regulariter dispositis, majoribus, ut videtur levissime sigmoideis; petiolus nullus vel fere, basi 1.8 cm latus, ut rhachis inferior supra excavatus, dorso rotundato-triangularis, circ. 7 cm longus, sed segmento secundo utrinsecus 10-11 cm ab infimo remoto; segmenta infima angusta, dimidiae prob. rhacheos lanceolata, 50 cm circ. longa, 5 cm lata, rigida, inferne nonnihil sat subito angustata, superne longe acuminata, acuta, an bifida apicibus plus minus destructis incerte, utrinque viridia, costa media paleis subtus carens, et marginalibus nonnihil prominentibus, minus validis dextra sinistra paucis, paulo conspicuis, tenuibus nullis, frondis fragmenti apicalis segmenta longitudine et latitudine decrescentia, anguste lineari-lanceo-

lata, sensim acuminata, acuta; spadix 3(4?)-plo ramosus, pedunculatus, ramis primariis inferioribus longe pedunculatis pluribus; rami primo fusco-furfuracei, longitudinaliter plus minus angulosi; ramuli 9, 5-6 cm longi, in dimidio in internodiis 1 mm diam. paulo superantes, superne sensim attenuati, ad apicem sat tenues, superne ad fructuum insertiones levissime flexuosi; florum glomeruli usque ad ramulorum apicem 3-flori, flore ♀ intermedio, ♂ juxtapositis, ♀ bracteis surgentibus conspicuis circumdato; flores ♂ 6 mm longi, ambitu ellipticooblongi, apice rotundati; calyx corollae arcte accumbens, 2.5 mm altus, 3 mm in diam. metiens, sepalis late rotundatis, minute ciliatis, inferne crassis, umbonatis; petala oblonga, crassa, apice obtusa; stamina numerosa, circ. 40; filamenta filamentosa, quam antherae breviores; antherae lineares, 2-3 mm fere longae, basi sagittatae, apice plerumque incisae, dorso ad basin affixae; pistillodium ad basin ipsam leviter fusiforme, superne filiforme, longitudine staminum, ut videtur rarissime haud evolutum; flores ♀ juveniles: sepala late rotundata, minute ciliata, inferne crassa, umbonata; petala rotundata, apice triangulari valvata; ovarium ambitu ovato-oblongum, stigmatibus 3 triangularibus; staminodia ut videtur plus minus in annulum connata; fructus maturus aurantiacus, i. s. cum perianthio 2.2 cm longus, ambitu oblongus, 1 cm in diam., apice rotundatus, apice mamillari, perbreviter latissime conico imposito, epicarpio minute longitudinem secus lineolato; pericarpium 1 mm in diam. metiens, mesocarpio fibris numerosis totam longitudinem secus percurso, endocarpio tenuiter pergamaceo, fragili; semen ambitu oblongum, 11 mm longum, 6 mm in diam. metiens, apice basique rotundatum, rhaphe totum latus secus extensa linearis, ramis ex rhapheos parte superiore pluribus atque dorso descendentibus parce furcatis et anastomosantibus; embryo basilaris; albumen aequabile; perianthium fructiferum cupuliforme, 7 mm. altum; calyx sat explanatus, humilis, 7 mm in max. diam. metiens, sepalis late rotundatis, longitudinaliter nervoso-striatis; petala latissime rotundata, apice valvato breviter triangulari, quam margines rotundati breviore; staminodia perpauca, latissime dentiformia.

Fiji: Vanua Levu, Thakaundrove, Yanawai River region, Mount Kasi, altitude 300-430 meters, May 10, 1934, A. C. Smith 1784, type.

Like the preceding, this palm grows in dense forest and is known as *niuniu*.

Genus GONIOSPERMA, genus novum

Spadix patenter ramosus; florum glomeruli spiraliter dispositi, ad majorem ramorum partem 3-flori; femineo intermedio, ♂ binis dextra sinistra juxtapositis, apicem ramorum versus ♂ geminis, glomeruli superficialiter fere axi inserti, sed axi infra in forma bracteae triangulariter conspicue producta; flores ♂ symmetrici; calyx sepalis late rotundatis, nonnihil imbricatis; corolla petalis valvatis, circ. oblongis, apice obtusis; stamina 6 introrsa; filamenta applanata, inter longiora, apice geniculatim nonnihil inflexa; antherae lineares, thecis intus dense parallelis, connectivo dorsili angusto, dorso modice infra dimidiam insertae, basi incisae, apice paulo emarginatae vel

incisae; pistillodium cylindricum sat robustum, quam stamina brevius; flores ♀ : sepala nonnihil imbricata rotundata; petala imbricata, apicibus triangularibus valvata; staminodia prob. 6, dentiformia; gynaeceum oblongum, stigmatibus 3 triangularibus; ovulum totam longitudinem secus affixum; fructus inter majores, globosi, apice modice excentrico mamillato, carnosi; epicarpium nitens, fere laeve, minute haud dense gibbosum; mesocarpium carnosum, fibris nullis; endocarpium tenuiter osseum, prob. longitudinaliter 4-angulare; semen longitudinem secus acute 4-angulare, apice oblique excavato-obtusum; rhaphe in angulo totum latus secus pertensa, linearis; embryo basilaris; albumen homogeneum. Palma altitudinis mediocris, foliis petiolatis, regulariter pinnatisectis; segmenta nervo primario unico, apice acuta.

The type of the genus is designated as *G. vitiense*. The genus is related to *Physokentia* Beccari, based on *P. tete* Beccari, of which I have not seen material. From description, the flowers of that species seem very similar to those of the new genus. The pinnae are premorse at the apex rather than acute. According to the description and figure, the seed of *Physokentia* is without distinct acute longitudinal edges, typical of the new genus. The rhaphe of *Physokentia* is not described.

The new species here described is certainly very near *G. thurstonii*, possibly even identical with it. The earlier species is known only from the fruit, so that a comparison of it with *G. vitiense* is hardly possible. In my opinion it is preferable to describe a new species rather than to establish a genus on a possible mixture of two species.

Goniosperma vitiense, species nova.

Palma caudice 4 m alto, petiolo 30 cm longo, lamina 3 m longa, segmentis utrinsecus circ. 40; rhachis prob. circ. dimidiae frondis humiliter triangularis, lateribus nonnihil excavatis, subtus levissime rotundata, utrinque ut videtur fusco-furfuracea atque dense fusco-leproso-unctulata; segmenta lineari-lanceolata, fere rectilinearis, apice vix falcata, visa regulariter disposita, opposita vel fere, sequentia 6.5 cm circ. dissita, a rhachi patentia, sed leviter surgentia, 75 cm circ. longa, 6 cm circ. lata, maxima latitudine ut videtur in dimidia parte circ. sita, inferne sensim sed conspicue angustata, basi conspicue reduplicata, superne sensim attenuata, apice acuto haud producto, textura sat rigida, supra glabra, subtus praecipue inferne in nervis validioribus paleis badiis plus minus oblongis praedita et in nervis nervulisque minutissime fusco-lepidota, supra in nervis validioribus fere plicata; spadix infra frondes 50 cm circ. longus; rhachis applanato-subtriangularis, decidue breviter furfuracea; rami ramulique basi bractea modice triangulariter producta suffulti; rami primarii

patentes, visi ramulis 3-2 vel simplices; ramuli floriferi visi 16-20 cm longi, inferne i. s. 2 mm in diam., superne angustati, apice flexuosi, tenues; florum glomeruli in spira sat laxa dispositi, ad 2/3 ramulum fere 3-flori, superne ♂ tantum geminis; glomeruli superficiales, axi infra in forma bracteae triangularis acutae excavatae retrorsae producta; flores ♂ 6 mm et paulo ultra longi, ambitu elliptico-oblongi; calyx 2 mm altus, sepalis late rotundatis, margine brunneo ciliato; petala oblonga, sat crassa, i. s. dense nervoso-striata, apice obtusiuscula; stamina 6, in flore inaperto longitudine petalorum; filamenta geniculata, nonnihil inflexa, usque ad genu 3.5 mm longa, applanata; antherae lineares, 3.5 mm longae, basi nonnihil, apice plerumque breviter incisae, modice infra dimidium dorsum affixae; pistillodium cylindricum, sat robustum; flores ♀ quam masculi juxtapositi modice minores, juvenes breviter ovato-pyramidati; sepala late rotundata, dorso umbonata; petala apice breviter triangularia valvata; staminodia ut videtur 6 dentiformia plus minus oblonga; gynaeceum oblongum; stigmata 3-angularia; ovulum parietale, totum latus secus affixum; fructus bracteis obsoletis, insertione horizontali orbiculari, carnosi, cocti fere globosi, 2 cm in diam., rubri, nitentes, i. s. minutissime haud dense granulosi; perianthium 11 mm in diam., fere explanatum; calyx brevissime cupularis, humilis, 7.5 mm in diam., sepalis late imbricatis, late rotundatis, ciliatis, demum inciso-rotundato-lobulatis; petala late rotundata, demum breviter irregulariter inciso-lobulata, margine ciliata, extus i. s. nervoso-striata, apice breviter late triangulari-valvata; apex modice excentricus, obsolete mamillatus, brevissime late conicus; stigmatibus 3 minutis, linearibus, recurvatis; pericarpium siccum 0.5 mm in diam. vix superans; mesocarpium i. s. tenue, i. v. carnosum, endocarpium tenuiter osseum, ¼ mm circ. in diam., ut videtur longitudinaliter angulare; semen 1.4 cm longum, 0.9 cm in diam., longitudinem secus acute 4-angulare, inferne attenuatum, superne dilatatum, apice oblique leviter excavato-truncatum, angulis carinatis; rhaphe in angulo totum latus secus pertensa, rhapheos rami in semine non perfecte maturo haud certe recognoscendi, ex endocarpii facie interiore ut videtur minus numerosi, transverse currentes et descendentes, parce furcati et anastomosantes; embryo basilaris; albumen homogeneum.

Fiji: Vanua Levu, Thakaundrove, Mount Mariko, altitude 600-866 meters, November 14, 1933, A. C. Smith 417, type.

The species grows in dense forest and is known as *niuniu*.

Goniosperma thurstonii (Beccari), combinatio nova.

Cyphosperma ? thurstonii Beccari, Webbia, vol. 4, p. 272, 1914.

Fiji: Taveuni, altitude 700 meters, Thurston.

Genus TAVEUNIA, genus novum

Spadix duplicato-multiramosus, pedunculatus, ramis primariis inferioribus nonnihil pedunculatis, rhachi elongata; florum glomeruli spiraliter dispositi, sat scrobiculati, axi infra in labium rotundatum nonnihil producta, in ramulis inferne biflores, flore femineo et masculo juxtapositis, superne masculo solitario; flores ♂ symmetrici: calyx sepalis nonnihil imbricatis, late rotundatis; corolla petalis valvatis,

apice obtusis; stamina 6; filamenta libera, filiformia, sat evoluta, apice breviter inflexa; antherae oblongae, primo introrsae, dorso connectivo sat lato, in medio dorso affixae, basi incisae, apice integrae; pistillodium sat evolutum, longitudine staminum, cylindricum, validum, apice capitatum; flores ♀ : sepala imbricata rotundata; petala imbricata, apice triangulariter valveta; staminodia dentiformia; gynaeceum oblongum, stigmatibus 3 triangularibus crassis; ovulum parietale. Palma altitudinis mediocris, foliis regulariter pinnatisectis; segmenta apice acuminata, acuta, nervis vadidis 3 percursa, margine haud incrassato.

It is very difficult to ascertain the character of the placentation in young female flowers, but it appears to be parietal, with the ovules affixed along the whole side of the ovary. The affinity of the new genus seems to be with *Aktinokentia* Dammer, which also has symmetrical male flowers. That genus is distinguished from the new one by the great number of stamens and the quite different shape of the pistillodium.

Taveunia trichospadix, species nova.

"Palma 15-20 pedes alta, caudice ad basin 4-6 cm in diam. metiente; frondes 2½ pedes longae, erectae, superne cernuae;" petiolus ad apicem ut rhachis ad basin supra in dimidio planus vel leviter concavus, lateribus oblique excavatis, marginibus acutis, subtus minutissime fusco-lepidulosus; segmenta infima 3 visa regulariter disposita, directione haud variantia, horizontaliter a rhachi patentia, infimum nervis primariis 2 percursum, rhachin secus 1.3 cm latum, 32 cm longum, 2 cm fere latum, conspicue sigmoideum, longe anguste acuminatum, reliqua visa 3-nervia nervo primario unico, lateralibus 2 validis, rhachin secus 1 cm lata, conspicue sigmoidea, quam infimum longiora, circ. 2 cm et paulo ultra lata, a dimidio circ. inferne sensim angustata, superne longe anguste acuminata, summo apice destructo, sed certe acuto, costa media versus summum apicem lateri approximata, inter costam mediam et lateralem validam nervi magis conspicui 3-4; segmenta textura sat rigida, subtus pallidiora, in nervis nervulisque minutissime fusco-lepidulosa; spadix duplicato-ramosus; pedunculi fragmentum superius 13 cm longum visum, nonnihil applanatum, apice 6 mm latum, ut rami ramulique trichomatibus paleaceis, lacerato-ciliatis, i. s. pallide fuscis vel fere cinereis dense furfuraceum; rhachis et rami ramulique longitudinaliter angulosi; rhachis 26 cm longa, haud flexuosa; rami ramulique basi bractea conspicua plus minus triangulariter ovata suffulti, basi in angulo interiore nonnihil callosi, rami primarii inferiores 8 ramosi, 7 reliqui simplices, infimi 2 ramulos 7 emittentes, rami imi pedunculus 8.5 cm longus, rhachis 7 cm; ramuli vix curvati, haud flexuosi, longiores 18 cm, breviores circ. 12 cm longi, inter tenuiores, floriferi in parte validiore, inferiore circ. 2 mm, in dimidia 1 mm (in internodiis) in diam. metientes, superne angustati, apice tenui acuto; florum glomeruli nonnihil foveolati, spiraliter inferne sat laxe, superne densiuscule dispositi; fovea margine inferiore nonnihil, late rotundato-producta; glomeruli in ramulorum parte inferiore dimidiam vix aequante

2-flori, flore ♀ et ♂ juxtapositis, superne ♂ tantum; flores ♂ parvi, symmetrici, fere ovati, 2.5 mm longi, apice rotundati; calyx 1.5 mm fere altus, sepalis i. s. dorso carinatis, margine late rotundato ciliato, extus nervoso-striatis; petala valvata, sat firma, apice obtusa, dorso longitudinaliter conspicue nervoso-striata; stamina 6; filamenta libera, filiformia, sat evoluta, apice geniculato-inflexa; antherae oblongae, 1 mm longae, introrsae, in medio dorso affixae, basi incisae, apice integrae; pistillodium longitudine staminum, robustum, cyclindricum, apice nonnihil capitatum; flores ♀ bracteis surgentibus, foveae labrium vix superantibus; sepala rotundata, late imbricata, longitudinaliter ut petala nervoso-striata; petala imbricata, apice triangulariter valvata; pistillodium obovato-oblongum, stigmatibus 3 triangularibus; ovulum parietale.

Fiji: Taveuni, October 2, 1881, C. Weber 112, type in herb. Berlin.

The species is said to be widely distributed in the hills of Taveuni, generally below 300 meters.

PRELIMINARY NOTES ON SARCOPYGME, A NEW RUBIACEOUS GENUS FROM SAMOA

By

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BERNICE P. BISHOP MUSEUM

OCCASIONAL PAPERS

VOLUME XI, NUMBER 5

HONOLULU, HAWAII

PUBLISHED BY THE MUSEUM

June 5, 1935

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In 1898 Reinecke[1] extended the range of *Sarcocephalus* to include the Samoan Islands, describing a new species, *Sarcocephalus pacificus*. In 1908 Lauterbach[2] described an additional species from Samoa, *Sarcocephalus ramosus*, and Rechinger[3] and Hochreutiner[4] also record *Sarcocephalus pacificus* for Samoa.

In 1921 Setchell[5] discovered plants on Tutuila which are undoubtedly congeneric with *Sarcocephalus pacificus* Reinecke, finding, however, that they could not be referred to this genus. They were temporarily placed in the genus *Breonia*, but a closer examination of the more ample material collected later by Setchell, Christophersen, and others on all the larger islands of Samoa has definitely proved that the plants of this affinity group belong to an undescribed genus, for which we propose the name *Sarcopygme*. The name alludes to the character of the infructescence, the ovaries being united into a fleshy fist.

Sarcopygme shows a superficial resemblance to *Sarcocephalus* in the fruiting heads, but is markedly different from this genus in its single ovules in each cell of the ovary. In *Sarcocephalus* the cells of the ovary are multiovular. The ovules in both genera are anatropous, but they are ascending or erect in *Sarcopygme*, horizontal or pendant in *Sarcocephalus*.

Sarcopygme is most closely related to *Morinda* as typified by *M. citrifolia* Linnaeus. Points of difference are: *Sarcopygme*, stipules caducous, involucre present, all (or most) flowers in the head open simultaneously, calyx distinct, stigma club-shaped; *Morinda citrifolia*, stipules persistent, involucre absent, only a few flowers open at a time, starting from below, calyx indistinct, fleshy, stigma 2-parted.

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[1] Reinecke, F., Die Flora der Samoa-Inseln: Engl. Bot. Jahrb., vol. 25, pp. 684-685, 1898.

[2] Lauterbach, C., Beiträge zur Flora der Samoa-Inseln: Engl. Bot. Jahrb., vol. 41, p. 235, 1908.

[3] Rechinger, K., Botanische und zoologische Ergebnisse, etc.: Akad. Wiss. Wien, Denschr., vol. 85, p. 366, 1910.

[4] Hochreutiner, B. P. G., Plantae Hochreutineranae: Candollea, vol. 5, p. 252, 1934.

[5] Setchell, W. A., American Samoa: Carnegie Inst. Washington, Dept. Marine Biol., vol. 20, pp. 44-45, 1924.

Genus **SARCOPYGME**, genus novum

Arbores parvae vel mediocres, caule simplici vel ramoso. Folia in parte superiore ramorum caulisque congesta magna plerumque lanceolata. Stipulae magnae caducae. Inflorescentiae capitatae axillares, pedunculis longis crassis erectis vel ascendentibus deinde nutantibus. Involucrum bi- vel uni-seriatum, exterius inflorescentias novellas includit irregulariter laciniatum plerumque non persistens, interius irregulariter laciniatum vel in segmentis liberis foliaceis petiolatis divisum. Flores bisexuales. Calyx cupuliformis deinde urceolatis truncatus plerumque leviter et irregulariter dentatus persistens. Corolla infundibuliformis in segmentis 5 (4) albis valvatis profunde divisa mox decidua. Stamina 5 (4) in fauce corollae inserta inclusa, antheris linearibus introrsis parte inferiore excepto adnatis. Stylus longus exsertus filiformis, parte suprema leviter incrassata, apice plano in sicco interdum convexo stigmatoso. Discus convexus latusque vel annularis. Receptaculum carnosum. Ovarium in receptaculo immersum indistincte 4-loculare. Ovula in parte inferiore loculorum inserta in loculis solitaria ascendentia vel erecta anatropa, micropylo infimo, rapha ventrali. Syncarpium succulentum. Pyrena anguste obovoidea irregulariter compressa, putamine rugoso osseo crasso. Semen plano-obovoideum, albumine oleagineo.

Sarcopygme pacificus (Reinecke), combinatio nova.

Sarcocephalus pacificus Reinecke: Engl. Bot. Jahrb., vol. 25, p. 681, pl. 13, *C*, 1898.

Type: Upolu, Graeffe no. 40 (= Reinecke no. 1623) (herb. Hamburg). Reinecke[1] also cites a specimen collected by himself (Upolu, Tofua, November 1893, no. 168) but we have not been able to locate this specimen.

Sarcopygme ramosus (Lauterbach), combinatio nova.

Sarcocephalus ramosus Lauterbach: Engl. Bot. Jahrb., vol. 41, p. 235, 1908.

Type: Savaii, Mataana, altitude 1,600 meters, September 20, 1906, Vaupel no. 525 (herb. Berol.).

[1] Reinecke, F., Die Flora der Samoa-Inseln: Engl. Bot. Jahrb., vol. 25, pp. 684-685, 1898.

Sarcopygme Mayorii (Setchell), combinatio nova.

Breonia (?) Mayorii Setchell, pro parte: Am. Samoa, p. 44, pls. 6 and 7, 1924.

Type: Tutuila, trail to Matafao, January 1922, Setchell no. 419. leg. Siitupe (herb. Univ. Calif., no. 215951).

CHECK LIST OF THE EMBIIDAE (EMBIOPTERA) OF OCEANIA

By

KARL FRIEDERICHS

BERNICE P. BISHOP MUSEUM

OCCASIONAL PAPERS

VOLUME XI, NUMBER 7

HONOLULU, HAWAII

PUBLISHED BY THE MUSEUM

1935

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By KARL FRIEDERICHS

No embiids are known from New Zealand, and no definite species but only undeterminable larvae are known from New Guinea. The other islands of Oceania have, as far as is known, no endemic embiids. In some of them two species are found, one of Asiatic, the other probably of African origin, but now at home everywhere in the tropics.

SUBFAMILY OLIGOTOMINAE HANDLIRSCH

Aposthonia (Oligotoma) vosseleri Krauss.

Aposthonia vosseleri Krauss: Zoologica, vol. 23, pt. 6, p. 48, 1911. Enderlein: Coll. Zool. Selys-Longchamps, vol. 3, p. 101, 1912.
Oligotoma vosseleri, Silvestri: Nat. Hist. Juan Fernandez and Easter Island, vol. 3, pt. 3, p. 328, 1924.
Embia species = *A. vosseleri*, female, Friederichs: Capita Zoologica, Deel 2, avl. 1, p. 10, 1923; Archiv. f. Naturgesch., new ser., Bd. 3, p. 409, 1934.

Forms of this species, besides the main form, are:

Aposthonia vosseleri jacobsoni (Silvestri).

Oligotoma jacobsoni Silvestri: Tijdschr. voor Ent., Deel 55, p. 334, 1912.
Aposthonia vosseleri jacobsoni, Friederichs: Archiv. f. Naturgesch., new ser., Bd. 3, p. 409, 1934.

Aposthonia vosseleri intermedia Friederichs.

Aposthonia vosseleri intermedia Friederichs: Archiv. f. Naturgesch., new ser., Bd. 3, p. 409, 1934.

Aposthonia vosseleri nana (Roepke).

Oligotoma nana Roepke: Treubia, vol. 1, p. 20, 1919.
Aposthonia vosseleri nana, Friederichs: Archiv. f. Naturgesch., new ser., Bd. 3, p. 409, 1934.

The form *nana* is known from median Java only. The other forms occur together in the Sunda Islands and Malaysia.

In the "Natural History of Juan Fernandez and Easter Island," the species is mentioned as inhabiting Easter Island and the Marquesas.

Oligotoma insularis McLachlan.

Oligotoma insularis McLachlan: Ann. Mag. Nat. Hist., 5th ser., vol. 12, p. 227, 1883. Hagen: Canad. Ent., vol. 17, p. 143, 1885. Perkins: Ent. Monthly Mag., vol. 33, p. 56, 1897. Friederichs: Mitt. Zool. Mus. Berlin,

Bd. 3, p. 236, 1906, Arch. f. Naturg., new ser., Bd. 3, p. 413, 1934. Mills: Ent. Soc. America, vol. 25, p. 652, 1932. Bryan: B. P. Bishop Mus., Bull. 31, p. 91, 1926; Hawaiian Ent. Soc., Proc., vol. 8, pp. 239, 246, 1933. Perkins: Fauna Hawaiiensis, vol. 2, p. 88, 1899. Hawaii, Lesser Antilles. *Embia latreillei* Rambur: Hist. Nat. ins. Neuroptères, p. 312, 1842.

Oligotoma insularis McLachlan=*Oligotoma latreillei* (Rambur)? from Laysan, Nihoa, and Necker Islands.

According to Enderlein, *O. insularis* is probably identical with *O. latreillei.* As far as I could see from dry material sent me from Bernice P. Bishop Museum, in which the males, indispensable for determination, were broken, *O. insularis* is identical with *latreillei.* The specimens from Hawaii, the females of which were preserved in alcohol, were darker and larger than is usual with *O. latreillei.* There will be doubt about the identity of the two forms until alcohol-preserved males from Hawaii are examined.

Mr. E. H. Bryan, Jr., informs me that he has found several forms of embiids "more or less closely related to *O. insularis,*" on the Phoenix Islands, in Samoa, and in Fiji. It is improbable that an examination will reveal the presence of endemic Oceanic species, while it is to be expected that the species which are of cosmopolitan (oecumenic) distribution in the tropics, such as *O. latreillei,* will spread more and more over the Oceanic islands. I found no embiids in either Samoa or Tonga in 1912.

Oligotoma species, Krauss, Zoologica, Heft 60, p. 46, 1911.
New Guinea: Friedrich Wilhelm-Hafen.

? Oligotoma species, Krauss, Zoologica, Heft 60, p. 46, 1911.
New Guinea: Graget Island.

AUTOTOMY AND REGENERATION IN HAWAIIAN STARFISHES

By

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INTRODUCTION

Autotomy or the spontaneous loss of parts has for a long time been known to be a widespread phenomenon among echinoderms. In the Asteroidea this process manifests itself in two general ways, one consisting of the casting off of rays, the other and less common one involving the disk and resulting in the division of the animal into two parts by fission.

As early as 1872 Lutken (10)[1] suggested that in certain starfishes "a radiary division occurs in which cast-off arms formed new rays and a disk". In 1878 Haeckel (7) recorded his observations of "cometoid" spontaneous division and regeneration in species of *Ophidiaster (Linckia)*. He reported that rays were cast off and new arms, disk, mouth, madreporites, etc., were developed from the base of the cast-off parts.

Following the observations of Lutken and Haeckel there was still considerable doubt that rays separated from a starfish had the capacity to regenerate a complete individual. Investigators generally expressed their belief that a portion of the disk along with a severed ray was necessary to bring about the formation of a new starfish.

More recent investigations, however, have amply demonstrated that, in certain starfishes, the basal end of a ray severed some distance from the disk may form a new and complete individual. This method of asexual reproduction, however, seems to have been adopted by a limited number of asteroids, some members of the family Linckiidae showing it to a very high degree.

Kellogg (9) in 1904 observing numerous regenerating rays of starfishes on the reef at Apia, Samoa, inferred that *Linckia diplax* (Müller and Troschel) and *Linckia pacifica* Gray had the capacity

[1] Numbers in parentheses refer to the bibliography, p. 20.

[2] Fisher (U. S. Nat. Mus., Bull. 76, p. 243, 1911) pointed out that the species Monks studied was not *Phataria* but *Linckia columbiae* Gray.

to regenerate new animals from isolated arms. Although Kellogg did no experimental work with the species at the time, he suggested a possibility that the rays had been thrown off by autotomy instead of being torn off by enemies.

Working with *Linckia columbiae* Gray[2] in 1904 Monks (12) experimentally demonstrated the development of "comets" including new rays and disk from the basal end of isolated arms leaving no doubt about the spontaneous loss of rays and their subsequent regeneration into new individuals in that species.

The probable purpose of self-mutilation resulting in the loss of rays has been suggested by numerous workers. Studer (14) noting the arms of *Labidiaster* were cast off when swollen with mature eggs believed that the phenomenon was associated with sexual propagation. By a separation of the rays near the disk it was thought the eggs might be more rapidly and widely dispersed, thus increasing the possibility of sexual reproduction. Valentine (16) at Tortugas, Florida, observed that a large number of specimens of *Linckia* showed regeneration of rays but found no isolated arms. For the absence of separate rays he ascribes two possible reasons, one the mature age of the regenerating specimens and the other that the season was one of sexual inactivity. This investigator apparently correlated the loss of rays with sexual propagation.

Hirota (8), however, has pointed out that since very young specimens of *Linckia multifora* (Lamarck) with rudimentary gonads show evidences of having lost rays, the casting off of arms during the egg-bearing season would not seem to be primarily for fertilization purposes. Observations in Hawaii support the view of Hirota. From the fact that on the reefs of Oahu the loss of rays of *Linckia multifora* is constant throughout the year irrespective of the spawning season, which seems to extend from December to May, it may be assumed that the phenomenon represents a natural method of asexual reproduction.

Spontaneous division involving the disk is of common occurrence among several genera of the family Asteriidae. Fisher (6) records the phenomenon in the genera *Coscinasterias, Sclerasterias,* and *Stephanasterias.* He found that in *Sclerasterias* fission through the disk takes place only in very young specimens while in the other two genera fissiparity continues into the adult phase. Fisher noted that in very young specimens of *Sclerasterias,* which normally have

six rays, the madreporites are symmetrically placed, and concluded that their position favors fission of the disk.

Lutken (10) observed the result of spontaneous division in *Asterias tenuispina* Lamarck, now *Coscinasterias tenuispina* (Lamarck), noting the disparity in the size of the rays. If a specimen had 6 rays these were separated into two groups of 3 approximately equal rays, those of the two groups being unequal, and if the specimen possessed 7 rays these fell into two divisions of 4 and 3 rays each. Farquhar (5) described a species in New Zealand, *Stichaster insignis,* now *Allostichaster insignis* (Farquhar), which exhibited fission through the disk. The normal number of rays was 6 but their irregularity was very pronounced as the author showed by a large number of figures.

More recently Bennett (1) in discussing autotomous reproduction in certain New Zealand starfishes suggested that the number of rays exceeding five is connected with the capacity of multiplication by transverse division, especially in *Allostichaster insignis* (Farquhar), *Allostichaster polyplax* (Müller and Troschel), *Coscinasterias calamaria* (Gray), and perhaps *Asterina regularis* (Verrill).

Crozier (3) in a critical examination of *Coscinasterias tenuispina* (Lamarck) found the usual number of rays to be 7 and that these fall into groups of 3 and 4 rays, as was noted by Lutken, the difference in the two groups being due to regeneration of parts of spontaneously divided disks. In more recent work on the same species Crozier (4) observed that fission alternated, to a large extent, with sexual reproduction, which occurred during the months of January and February.

Although the cause initiating transverse fission in starfishes is by no means clear, the position of the madreporites has been most frequently proposed as a possible stimulating factor. Since it has been shown that in starfishes with unequal rays usually the longest ray, or a long ray near the madreporite, is the "directive ray" in movement, Crozier (4) suggests that as madreporites multiply in number each new one may furnish an additional "physiological anterior point" and thereby provide conditions favorable to fission.

In order to determine the extent of the phenomena of autotomy among Hawaiian starfishes and to follow the processes involved in the regeneration after natural or artificial injury a series of investigations extending over a period of approximately three years was con-

ducted with the species of local asteroids most available. Specimens of *Linckia multifora* were obtained from Kaneohe Bay, Oahu, and *Linckia diplax* from Honaunau, Hawaii, and Kaneohe Bay, Oahu. A small race of *Coscinasterias acutispina* Stimpson was taken from Maalaea Bay, Maui, and larger specimens from Kaneohe Bay, Oahu. Specimens of *Pentaceros hawaiiensis* Fisher were collected at Maile Point, Oahu, and *Dactylosaster cylindricus pacificus* Fisher and a small undetermined form, probably *Nepanthia* species, at Black Point, Oahu. Experimental work on regeneration was conducted on the leeward and windward reefs of Oahu as well as at the Marine Biological Laboratory at Waikiki. I am indebted to Ray J. Baker for assistance in the pursuance of this investigation.

OBSERVATIONS

Linckia multifora (Lamarck) and **Linckia diplax** (Müller and Troschel).

Both *Linckia multifora* and *Linckia diplax* are plentiful in certain localities about the Hawaiian islands. Kaneohe Bay, Oahu, is a favorable habitat of these species, *Linckia multifora* being more abundant here. At Honaunau Bay, Hawaii, *Linckia diplax* was found to be the predominating starfish in 1931.

That autotomy of rays in these two species is a widespread phenomenon, as in other members of the genus, has been the observation of Kellogg (9) at Samoa and Hirota (8) in Japan. This is equally true of the species in Hawaii and especially of *Linckia multifora*. In Kaneohe Bay seldom may a perfectly symmetrical example of this species be found on the reef, one or more rays almost invariably showing evidences of regeneration.

Typically the species has 5 rays. In a lot of 85 specimens, two had 6 rays and seven had 4 rays. In a lot of 52 animals 107 rays showed evidence of autotomy at some previous time; in another group of 85 specimens 238 breaks in rays were counted and in a third lot of 137 animals the number of breaks indicating autotomy was 298. In the latter lot 17 of the breaks were 40 mm or more from the disk and 216 were 25 mm or less from the disk. These breaks, in some instances at least, having occurred several years previous to the time of observation, actually took place somewhat nearer the disk than is indicated by the above data as some account must be taken of the linear growth of the basal portion of the ray.

In Kaneohe Bay a considerable number of recently detached rays may be found on the reef at all seasons of the year as well as "comets" in all stages of development (fig. 1, *c*). The number of free rays and comets, however, is by no means commensurate with the number of regenerated rays of living specimens. This may be explained by a high rate of mortality of freshly isolated rays together with their increased facility, because of small size, for concealment among branching corals and porous rocks on the reef.

My observation is that in Kaneohe Bay *Linckia diplax* shows less tendency toward autotomy of rays than does *Linckia multifora.* Large symmetrical specimens of *L. diplax* with 5 or 6 rays and no indication of autotomy having taken place are not uncommon in this locality and few detached rays or comets of this species are to be seen. Experimental evidence, however, indicates that severed rays of *Linckia diplax* regenerate new individuals quite as freely as do those of *Linckia multifora.* At Honaunau Bay, Hawaii, in 1931 a series of small forms of *Linckia diplax* was discovered, each individual showing autotomy of one or more rays. It is quite likely that the young of this species exhibit self-mutilation to a greater degree than do older and more mature individuals.

The actual process of the spontaneous separation of a ray from a starfish has seldom been observed. MacBride (11) states: "Even a single arm may regenerate the whole starfish. Now in some cases (Astropectinidae, Linckiidae) starfish will readily snap off their arms on irritation." The casting off of a ray in *Linckia multifora,* as I have observed it, is not a snapping process but a slow pulling apart. It begins on the ventral surface by a transverse separation of adjacent ambulacral ossicles, the break then spreading laterally and dorsally. A steady pull of the animal and ray in opposite directions by the action of the tube feet finally completes the separation, the areolar tissue sometimes stretching for a distance of two inches before parting (fig. 1, *a*). The entire process may be accomplished in about 60 minutes, the time varying, however, with the activity of the animal.

There seems to be no definite point of weakness in the arm of *Linckia multifora* where autotomy usually takes place, although local observations indicate that most fractures occur about 1 inch or less from the disk. Crozier (4) noted a "breaking joint" in the arm of *Asterias tenuispina* Lamarck, now *Coscinasterias tenuispina* (Lamarck), at the fifth ambulacral ossicle.

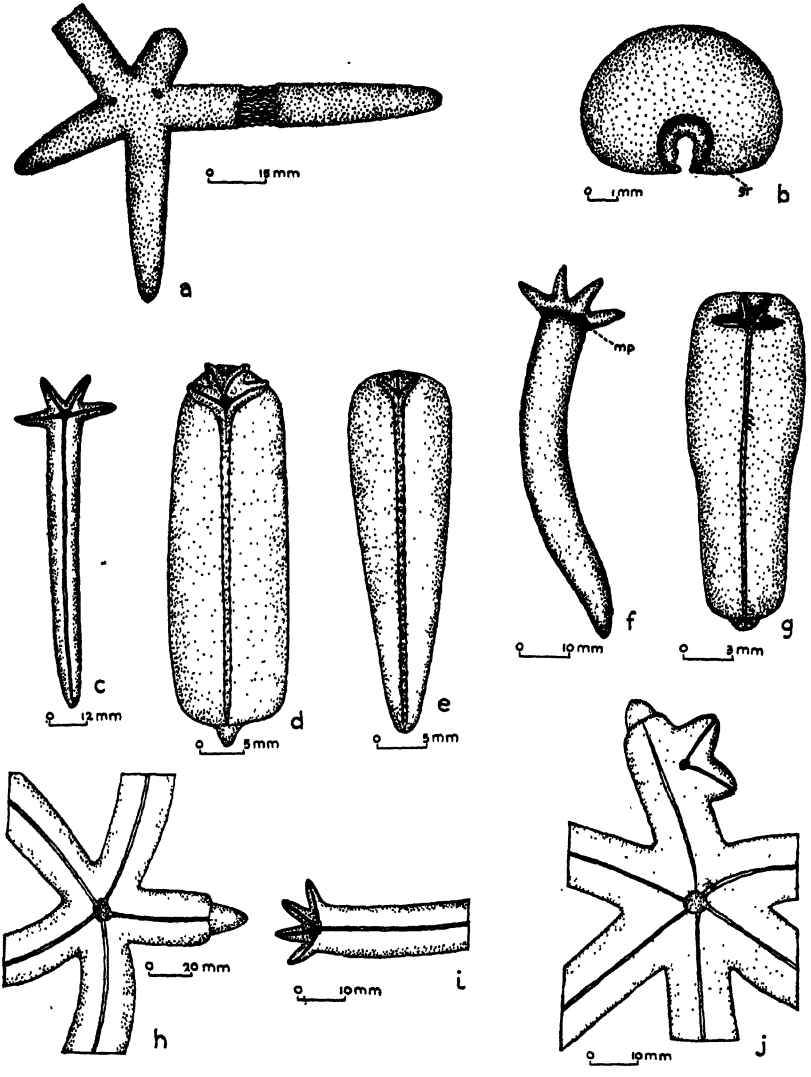

FIGURE 1.—*Linckia multifora* (*a, b, c, g, j*); *Linckia diplax* (*d-f, h, i*): *a*, autotomy nearing completion, the areolar tissue stretching as the ray is separated; *b*, "germinal ridge," *gr*, formed about ambulacral groove at injured end of a ray; *c*, a "comet" taken from the reef; *d, e*, basal and distal segments, respectively, of the same ray showing gradation of regeneration; *f*, a severed ray with madreporite, *mp*, after 10 months' regeneration; *g*, segment of an arm with rays developing at both ends; *h, i*, regeneration of an artifically severed ray after 10 months; *j*, six-rayed specimen with a branched arm.

The slow pulling apart of the arm results in irregular and ragged injured surfaces both of the stump of the ray and the proximal end of the separated portion. Closure of the open ends is accomplished by an infolding of the tissue of the dorsal, lateral, and, to a lesser degree, of the ventral walls, this overgrowth requiring about 10 days for completion. A smoother and more rapid closure occurs in rays artificially severed than in those naturally pulled apart.

The rapid proliferation of the integument resulting in a closure of the injured end may possibly be due to an activating agent which speeds up cell division. Discussing regeneration in nemerteans Coe (2) says: "Cut nerve cords liberate some influence, not improbably a growth-stimulating substance which acts superficially upon dormant cells of the neighboring parenchyma, transforming them into active regenerative cells and directing their movements forward."

The nature of the stimulus or stimuli initiating autotomy in starfishes is not clear. Various external factors in the form of irritants seem to be effective in some instances and a general alteration of ecological conditions has at times apparently aroused a marked increase in spontaneous casting off of rays. In a lot of 50 specimens of *Linckia multifora* brought from the reef and placed in laboratory tanks of circulating sea water, 18 had lost one or more rays within 18 hours. This change was doubtless one affecting the general metabolism of the animals. Crozier (3) noted that the autotomy of rays in *Coscinasterias tenuispina* was induced by localized stimuli such as injury, holding the ray, or an application of acid. I have caused arms of *Linckia multifora* to be cast off at different levels by lightly binding the ray with fine copper wire.

After having been naturally or artificially separated from the disk the rays have a tendency, as Monks (12) observed, to cling to the sides of the aquarium with the injured end down. Following the closure of the injured end the ray moves about more freely, usually seeking the surface of the water and frequently creeping out of the uncovered aquarium entirely.

Under laboratory conditions and assumably under natural conditions on the reef the mortality rate of isolated rays is very high during the first few days following either autotomy or artificial severance. Apparently bacterial infection is responsible for a large percentage of the early losses. Rays artificially sectioned two or more times are doubly exposed to the inroads of infection by reason

of injuries at both extremities. If the severed ray survives until the end is closed by overgrowing tissue the chances are much greater for the formation of a new individual.

In a detached arm the approaching development of new rays at the proximal end is forecast by the appearance of a crescent-shaped ridge of tissue about the ambulacral groove. This ridge, which I have called the "germinal crescent," is usually sharply contrasted in color from the surrounding tissue, being of a yellowish tint. The crescent is first observed after the ray has been isolated for six or seven weeks (fig. 1, *b*). Soon the crescent becomes marked transversely by furrows which develop into ambulacral grooves, and a mouth is formed at the point from which the grooves radiate (fig. 1, *d, e*). As growth continues, the rays, at first very broad for their length, become longer and thicker with their boundaries more completely differentiated. For some time the rays are confined to the end of the arm of which they are an outgrowth but after about three months they begin to extend beyond the boundaries of the parent ray, this extension being the beginning of the formation of a disk. In six months' time the new rays are about 8 mm long, and in 10 months they have reached a length of 10 mm (fig. 1, *h, i*). These growth rates are for laboratory-controlled specimens. My experiments show that the rate of regeneration in the sea is approximately the same as in the laboratory.

Although tube feet appear in the newly formed ambulacral grooves before the rays are fully outlined, madreporites are not observed until much later. In *Linckia diplax* a madreporite first made its appearance after six months' regeneration, being indicated by a shallow depression in the newly formed discal tissue of the dorsal surface. After 10 months the madreporite becomes functional as is indicated by its reticulated surface. At this time the new rays have a length of 10 mm and a "half-disk" has developed (fig. 1, *f*).

Rays of *Linckia multifora* and *Linckia diplax* were artificially severed into 2, 3, and 4 sections to determine the smallest segment capable of regenerating a new individual and also to determine, if possible, the existence of a gradient development. Rarely in these experiments have even three segments of an arm survived to the point of formation of new rays. Frequently, however, two out of three segments survive. The results clearly show a gradation of development from proximal to distal extremity of a ray. In *Linckia diplax*

in a basal segment 40 mm long the initial rate of regeneration of new rays is much more rapid than in a distal section of the same arm and of equal length, the ratio of development being 2:1 (fig. 1, *d, e*). Here the middle section of the severed arm was lost before regeneration of rays occurred. Similar results were obtained for *Linckia multifora*. A basal segment 20 mm long was compared with a distal section of the same length. The initial development of new rays was more rapid in the basal segment. At the end of two months the rays at the proximal end of the basal segment are twice the length of those of the distal section. The disparity in volume between proximal and distal segments of equal length is, however, an appreciable amount. To compensate for the difference in volume basal segments of known length were compared with slightly longer distal sections. The ratio of initial rate of regeneration still remained 2:1 in favor of the basal segments. It should be noted, however, that the initial ratio is gradually altered until at the end of four months' development the rays of the distal segment equal in length those of the basal segment.

In like manner stumps of rays severed close to the disk show a more rapid rate of regeneration than do those cut farther from the disk. In an example of *Linckia diplax* with one ray, several 15 mm and another 42 mm from the disk, twice as much regeneration occurred in 60 days in the shorter arm as in the longer one.

Mid-ray sections of *Linckia multifora* 10 mm long regenerate rays and a disk, but tip-end segments 12 mm long seldom live more than 10 days. Sections 20 mm long from the tips of rays, however, are able to develop new rays 2 mm long in 113 days.

It is remarkable that a section of a ray less than 1 inch long will live indefinitely with the nerve cord severed and the water tube cut off from the natural supply. The behavior of the segment indicates that the nervous system functions normally and that the tube feet carry on their activities as usual. The demonstration by Paine (15) of nerve cells comparable to a nerve net in the tube feet of starfishes would explain in part at least the maintenance of life in a small section of a ray. It is probable that organic matter is absorbed through the softer tissues exposed to the water in sufficient quantity to effect growth.

The formation of rays and a disk at both extremities of a segment of an arm is an unusual phenomenon. Only twice have I observed it

to take place among several hundreds of experimental specimens. The segment was each time from the middle of a ray and one involved in its distal half a section of a previous regeneration (fig. 1, *g*).

Other abnormalities may modify the form of the arms. Nusbaum and Oxner (13) describe and figure *Echinaster sepositus* Lamarck with branched rays. In a specimen of *Linckia multifora* from Kaneohe Bay, Oahu, two small rays are developing laterally from near the tip of a regenerating arm (fig. 1, *j*). The aberrant rays have their source several millimeters from the distal extremity of the arm from which they branch and probably were activated by an injury. To supply the needs of these abnormal rays a madreporite has developed dorsally and a mouth ventrally.

Coscinasterias acutispina Stimpson.

This species was first described from Japanese waters by Stimpson. It was collected in the central Pacific area at Kure Island and Pearl and Hermes Reef by the Tanager Expedition in 1923 and later discovered in Kaneohe Bay, Oahu. A dwarf race of the species was located along the rocky shore of Maalaea Bay, Maui, in 1931. Here large numbers of small specimens with rays ranging from 6 mm to 30 mm in length are to be found on the under surface of stones near shore. In Kaneohe Bay specimens with rays 90 mm long are not uncommon.

The dwarf race of Maui consists of fragmented and irregular individuals with rays ranging in number from 3 to 9 (fig. 2). Although the number of rays in normal specimens may vary, seven seem to be typical. The larger and more symmetrical specimens in Kaneohe Bay usually possess this number; a few, however, have 6 and some 8 rays.

A careful examination of asymmetrical specimens having from 6 to 8 rays indicates two unequal groups of rays. One group consists of 3 or 4 rays of nearly uniform size while opposite is another group of 3 or 4 rays of about equal size but larger or smaller than the first. That this asymmetry is a result of fission through the disk cannot be doubted and seems to follow the process as observed in other members of this genus and related genera by Crozier (4), Fisher (6), Farquhar (5), and others.

Typically the number of madreporites possessed by this species is four. It will be seen that a line bisecting the asymmetrical specimen, separating the groups of longer and shorter rays, falls between the two pairs of madreporites (fig. 3, *a*). The position of the madreporites evidently determines the direction which the line of fission takes. This is further supported by an examination of triradiate specimens (fig. 2, *a, c, f*) where two madreporites are seen to lie in a plane of the two opposite rays. The other two madreporites have been removed with the other portion of the disk during the process of fission.

From triradiate fragments (fig. 2, *a, c, f*) asymmetrical individuals with a full complement of rays are developed by regeneration (fig. 2, *b, g, k, l*). The additional madreporites appear as the disk is filled out on the side of the regenerating rays.

Fission seems to be the universal rule among members of this dwarf race and evidence of it is also seen among small specimens taken in Kaneohe Bay. In this locality, however, large symmetrical specimens with rays more than 3 inches long showing no signs of fission or regeneration are to be found. The asymmetrical arrangement of the madreporites is suggested as an explanation for the absence of fissiparity in large specimens (fig. 3, *b*).

There is no positive evidence that single rays in this species spontaneously separate from specimens at some distance from the disk as in the genus *Linckia* and regenerate new individuals at the proximal end. Arms of large specimens show no evidence of segmentation and regeneration and, among several hundred specimens taken on the reef, I have found no single rays and few if any fragments which may be considered "comets". Certain specimens (fig. 2, *h*) have the general appearance of comets but the presence of two well-developed madreporites in close proximity to the base of the large ray may indicate that a fragment of the disk remained with this arm as it separated. If this interpretation is correct the other two madreporites have not yet made their appearance.

Verrill (17) calls attention to the addition of rays in certain starfishes by budding, a phenomenon which in *Pycnopodia helianthoides* (Brandt) may continue until late in life. Such a condition is apparent in *Coscinasterias acutispina,* where occasionally young specimens with nine rays show one or more of these budded from the disk in a dorsal position instead of from the margin (fig. 2, *d*).

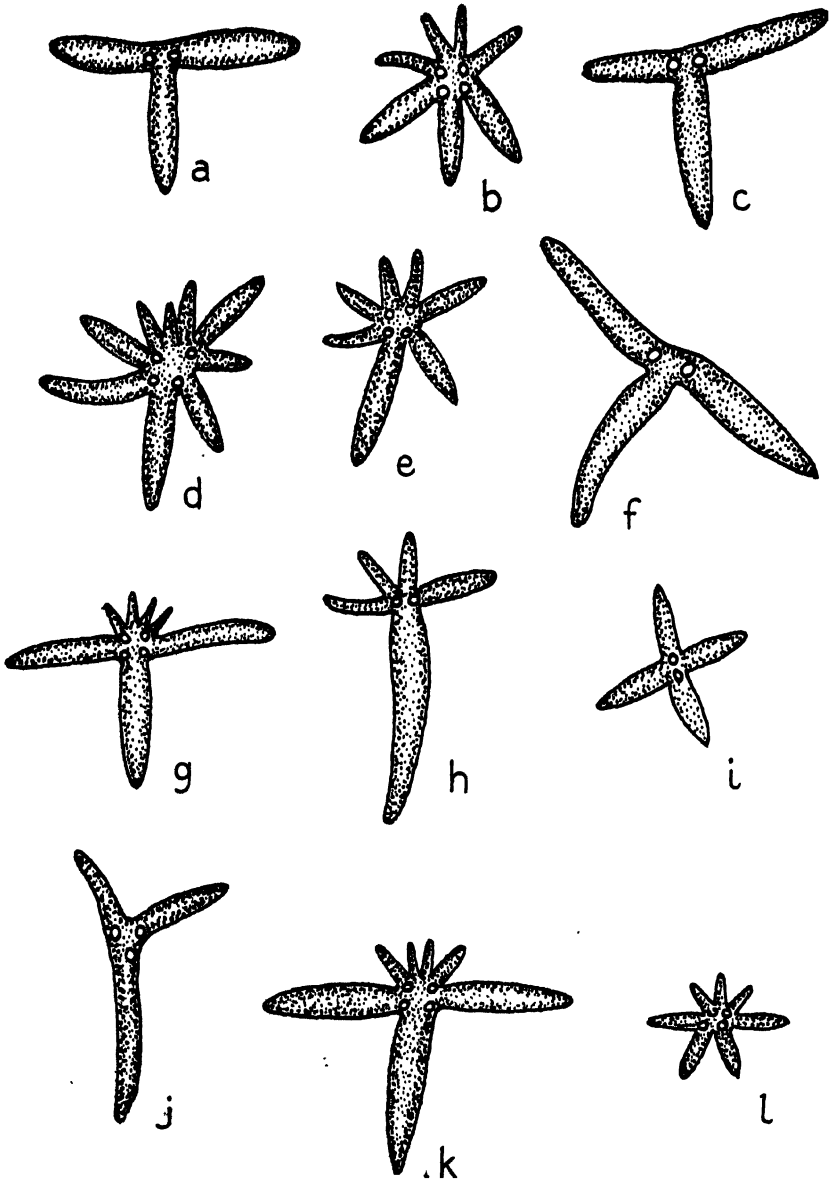

FIGURE 2.—*Coscinasterias acutispina* (*a-l*), 12 specimens of a small race from Maui showing results of fission through the disk. Natural size.

Repeated tests were made to determine whether rays of this species artificially severed have the capacity to regenerate new individuals from the proximal ends. The results were all negative, the severed rays dying without signs of regeneration. The several rays generally died within a few days but occasionally survived 30 days or longer. A ray severed 1 inch from the disk on August 19 lived until October 25, or 67 days, without showing regeneration. On several occasions under laboratory conditions single rays have spontaneously detached themselves at their junction with the disk and survived for a few days in an isolated condition. In this species the skin is very thin and delicate, which may partially account for an apparently low resistance in severed rays.

Autotomy in *Coscinasterias acutispina* follows a course of fission with the line of breakage penetrating the disk between two pairs of madreporites. The phenomenon is comparable to that occurring in *Coscinasterias tenuispina,* and in species of *Sclerasterias* and *Allostichaster* as recorded by Crozier (4), Fisher (6), Farquhar (5), and Bennett (1). The position of the madreporites as a favoring factor in spontaneous division, suggested by numerous investigators, is supported by my observations on the Hawaiian species.

Dactylosaster cylindricus pacificus Fisher.

The type specimen of this subspecies was collected at Laysan Island by the Tanager Expedition and other specimens were taken by the same expedition at Kure Island and from an unrecorded locality. More recently this species has been found to occur in considerable numbers on the Kahala side of Black Point, Oahu, where it is concealed in crevices of porous rocks in shallow water.

The species normally has five quite rigid, cylindrical rays and one madreporite. It differs from the typical species, *Dactylosaster cylindricus* (Lamarck) of the Indian Ocean, primarily in lacking pedicellariae.

Of the many specimens taken at Black Point most of them are quite symmetrical in form with rays of nearly equal length. Occasionally a specimen is found with one or more rays undergoing regeneration (fig. 3, *c*). No "comet" forms in which single rays exhibit regeneration have been observed under natural conditions and no isolated rays or fragments of rays have been found on the reefs.

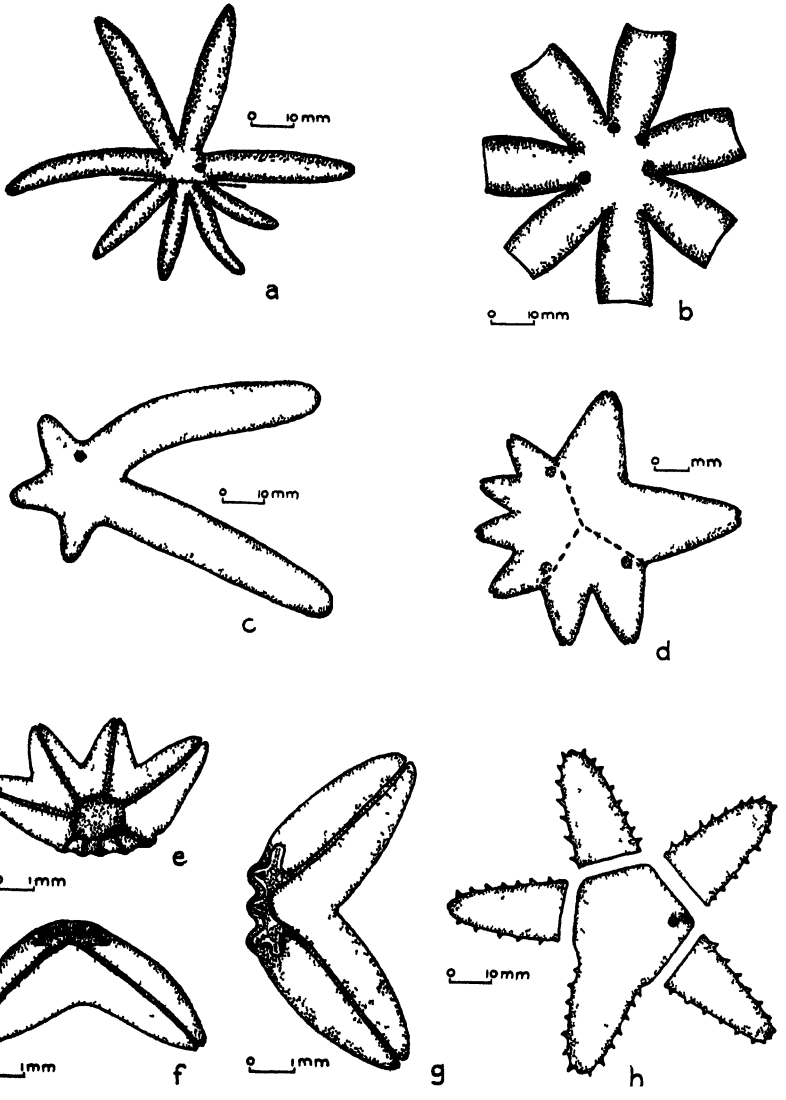

FIGURE 3.—*Coscinasterias acutispina* (*a, b*); *Dactylosaster cylindricus pacificus* (*c*); *Nepanthia* species? (*d-g*); *Pentaceros hawaiiensis* (*h*): *a,* an eight-rayed specimen with symmetrical arrangement of madreporites, dotted line indicates line of previous fission through disk; *b,* disk of a symmetrical adult with asymmetrical arrangement of madreporites; *c,* a regenerating specimen taken from the reef; *d,* a specimen cut into three sections as indicated by dotted lines; *e-g,* ventral view of sections (*d*) after two months' regeneration; *h,* a specimen with four rays severed close to the disk.

Autotomy, however, has been observed to take place under laboratory conditions. On these occasions the spontaneous separation of rays occurred within a few hours after specimens were transferred from the reef to circulating sea water of the laboratory. Spontaneous subdivision of artificially severed rays has also been observed under controlled conditions. When such rays fragment themselves the small sections all die within a few days.

Repeated experiments have been conducted to learn whether artificially severed rays of this species have the capacity of regenerating new rays at the injured end. The results have always been negative. Usually the rays die within a week and in the few which have lived for 30 or even 40 days no appearance of new rays has been indicated.

Although *Dactylosaster* belongs to the same family as *Linckia* it seems evident that autotomy and the regenerative capacity of isolated rays may be specific generic adaptations.

Nepanthia species?

A minute starfish, probably representing a small race of the genus *Nepanthia,* has recently been discovered in Hawaiian waters. It has been collected at Black Point and Maile Point, Oahu, and at Maalaea Bay and on the Maliko coast of Maui.

Few symmetrical specimens are found, nearly all having rays of unequal size. The number of rays varies, seven usually being present in the more symmetrical individuals. Large specimens have a total breadth of about 15 mm but tiny fragments 3 mm across, consisting of a part of a disk and two or three small rays, may be found. The surface is covered with irregular-shaped, imbricating plates which bear on the upper face of the free ends tufts of minute spinelets. A dull gray color renders the starfish inconspicuous as it clings to the under surface of stones in shallow water.

That this small form almost universally undergoes transverse fission there can be no doubt since nearly all show a loss of one quarter to one third of the disk together with several rays. The line of fracture is apparently quite straight and always excentric to the oral aperture. From the injured margin as many as five new rays may appear in regeneration.

Multiple madreporites are present in the species, although it is difficult to determine their number and position because of the imbri-

cating surface plates. In some fragmental specimens two madreporites are distinctly observed, in others three. They stand upon rounded tubercles at the height of the surface plates and are covered by spinelets. Their position in some specimens would suggest that fission took place parallel with the line of the madreporites and that a corresponding pair was removed by division. In other specimens the unsymmetrical arrangement of the madreporites cannot be related to the apparent line of discal fission.

A specimen with three visible madreporites was cut into three sectors each including a portion of the oral aperture (fig. 3, *d*). After 60 days each sector presented a reformed boundary of the mouth and regenerating rays in various phases of development (fig. 3, *e-g*). The section including 4 rays and 2 madreporites (fig. 3, *e*) made the greatest growth.

Single rays of this species have lived for more than 60 days without showing evidence of the formation of new rays at the basal end.

Pentaceros hawaiiensis Fisher.

This species was first collected by the Albatross Expedition in Hawaiian waters at depths ranging from 32 to 73 fathoms. Recently it has been found in considerable numbers on the reef at Maile Point, Oahu, close to shore. Here the specimens are small to medium-sized, the larger ones having a radius of about 85 mm. The species is typically five-rayed, very symmetrical, with a large disk and relatively short rays, the entire surface being covered with a thick leathery skin. One madreporite is present.

Although most specimens taken about Oahu are symmetrical in outline, the rays varying but little in size and length, occasionally an individual is seen with one or more rays very much smaller than the others. Here the short arm has a narrow base and shows no evidence of being a regenerated portion of a once longer ray. Among specimens examined I have found no rays presenting abrupt constrictions indicating mutilation and subsequent regeneration. No isolated rays or comets of this species have been found on the reef and neither autotomy of rays nor fission occurs under laboratory conditions.

Individual rays artificially severed close to the disk have lived for periods up to 58 days without signs of regeneration except for

the closing over of the injured surface by the thick skin, which is accomplished in about 10 days. Of four arms artificially separated from an individual (fig. 3, *h*) on August 2, one died on September 18, one on September 20, one on September 22, and one survived until September 29. None of the isolated arms showed evidence of the formation of new rays at the proximal end.

Regeneration of the stumps of arms severed close to the disk is exceedingly slow in this species. In a specimen thus mutilated no appreciable regeneration of the rays occurred after a period of four months.

It seems clear that the phenomenon of autotomy has not been adopted by *Pentaceros hawaiiensis* and that the isolated rays have no capacity to regenerate new individuals. Rays may regenerate following accidental loss, which apparently rarely occurs, but regrowth takes place very slowly.

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A NEW LATHRIDIID FROM TAHITI

(Coleoptera, Lathridiidae)

By

ELWOOD C. ZIMMERMAN

BERNICE P. BISHOP MUSEUM

OCCASIONAL PAPERS

VOLUME XI, NUMBER 9

HONOLULU, HAWAII

PUBLISHED BY THE MUSEUM

JULY 6, 1935

A NEW LATHRIDIID FROM TAHITI*

(Coleoptera, Lathridiidae)

By Elwood C. Zimmerman

INTRODUCTION

The family Lathridiidae is represented in Oceania, exclusive of New Zealand, by few species. None have been recorded from all of Micronesia, and all have heretofore been found only in Hawaii (three introduced, widespread species) and in the Marquesas in eastern Polynesia. It is noteworthy that no species have been discovered on such large island groups as Samoa, Tonga, Fiji, and the New Hebrides. The small size of the beetles, their ability to easily conceal themselves, and the habit of some species to fly at dusk and remain hidden away during the day have probably kept them out of the hands of collectors. There will undoubtedly be other species found on many of the islands of Oceania when more careful and thorough collecting is done.

The lathridiid fauna of New Zealand is a rich one. It is interesting to note that the some 60 species comprising this fauna make it more than three times as large as the lathridiid fauna of the entire Australian continent, and more than half as large as that of all America north of Mexico.

Genus **MUMFORDIA** Van Dyke

The following new species, found in the highlands of Tahiti, was the only species taken by the Mangarevan Expedition to southeastern Polynesia in 1934.

Mumfordia monticola, new species (fig. 1).

Derm dull black, covered with a greasy exudation; antennae, clypeus, and legs rufous. Head: hardly longer than wide, abruptly, laterally constricted before the eyes; clypeus separated from the front by an uneven sulcus, evenly rounded distally; a variable, poorly defined, tuberculiform granule on either side of the middle of the front, another on either side near inner margin of the eye; lateral margin behind the eyes with one or two variable spines; eyes prominent, the facets distinct, large, black and shining. Prothorax: wider

* Mangarevan Expedition Publication 1.

than long, minutely granulate, rather deeply constricted at posterior third, the constriction continuing prominently across the disk; margin with a large, heavy spine at middle and anterior angle, posterior angle with an obtusely rounded tubercle; disk with three stout spines either side the middle. Scutellum: not visible. Elytra: ovate, twice as long as wide, three times as long as prothorax, with four series of spines on each elytron, those on the sutural interval smallest and often rather indistinct, those in the outer three rows heavy and prominent; punctuation course, a single row of punctures marks the striae, spineless intervals very narrow and poorly defined. Beneath: dull and granular; ventrites 1-5 subequal in length, 6 short, 3-6 usually paler in color. Length: 1.6-1.8 mm; breadth 0.6-0 8 mm.

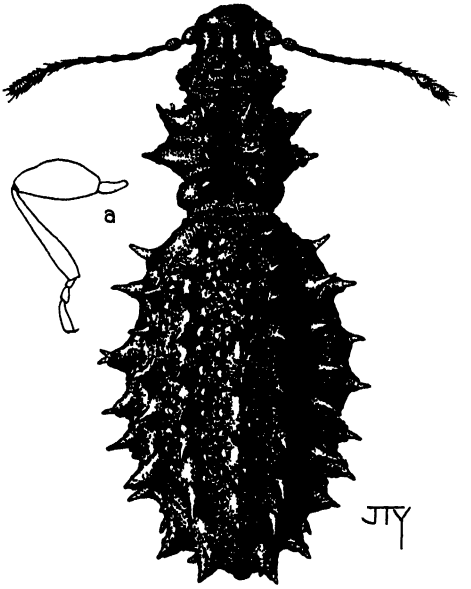

FIGURE 1.—*Mumfordia monticola,* new species, type; *a,* left fore leg of paratype.

Described from four specimens taken by me at altitudes between 5,500 and 6,300 feet on Mount Aorai Trail, Tahiti, Society Islands, September 15, 1934. The specimens were found beneath the incurled edges on the under sides of dead *Freycinetia* leaves hanging on the plants.

Type and two paratypes in Bernice P. Bishop Museum; the third paratype in my collection.

This species is most closely related to *Mumfordia spinata* Van

Dyke[1] from the Marquesas. *Mumfordia monticola* can easily be distinguished from *M. spinata* by the fact that its elytra are tumid, evenly arcuate in lateral outline, and bear four rows of spines, while the elytra of *M. spinata* are narrower, more parallel sided and bear five rows of spines. The spines of *M. monticola* are stouter and more pronounced than those of *M. spinata.*

There is some variation in the development of the spines. In one specimen, the sharp tips seem to have been broken off, leaving the spines blunt. There is a tendency for the prothoracic spines to become confluent for varied distances from their bases. When the specimens are illuminated by a strong lamp, the derm, especially of the elytra, appears reddish black. The constriction on the posterior third of the prothorax, and a variable sulcus that runs across the disk from between the two lateral spines, make the prothorax appear trilobed. There are two longitudinal carinae on the front of the type (a clean specimen) which are not clearly defined on the greasy-coated heads of the three paratypes. The antennal and leg structures are shown in figure 1.

CHECK LIST

The following check list of Lathridiidae includes species from Polynesia and eastern Melanesia. The first citation under each species name is that of the original description; the second is a locality record. If only one reference is given, it applies to both original description and geographical record.

For synonymy and detailed bibliography, see Schenkling, Coelopterorum Catalogus, pt. 85, 1926, Lathridiidae by Hetschko. For keys and classification, see Belon, Révue d'Entomologie, vol. 16, pp. 105-221, 1897; and Fall, American Ent. Soc., Trans., vol. 26, pp. 101-190, 1899.

Merophysiini

1. **Coluocera maderae** Wollaston.

Wollaston: Insecta Maderensia, p. 180, tab. 10, fig. 1, 1854.

Illingworth: Hawaiian Ent. Soc., Proc., vol. 7, p. 478, 1931.

Hawaii, Madeira, Burma, Brazil. Widely distributed.

[1] Van Dyke, E. C., Two New Lathridiidae from the Marquesas: B. P. Bishop Mus., Bull. 98, p. 237, fig. 52, *a*, 1932.

HOLOPARAMECINI

2. **Holoparamecus kunzei** (Aubé).
Aubé: Soc. Ent. France, Ann., ser. 2, vol. 1, p. 245, pl. 10, no. 1, fig. 4, 1843 (*Calyptobium*).
Heller: Nova Caled. zool., vol. 2, pt. 3, p. 246, 1916.
New Caledonia, Europe, Africa, China, America; widely distributed.

LATHRIDIINI

3. **Lathridius nodifer** Westwood.
Westwood: Intro. Mod. Class. Ins., vol. 1, p. 155, pl. 13, fig. 23. 1839.
Swezey: Hawaiian Ent. Soc., Proc., vol. 7, p. 185, 1928.
Hawaii (?). Cosmopolitan.

4. **Coninomus constrictus** (Gyllenhal).
Gyllenhal: Insecta Suecica, vol. 4, p. 138, 1827 (*Lathridius*).
Fullaway: Hawaiian Ent. Soc., Proc., vol. 5, p. 81, 1922.
Hawaii. Cosmopolitan.

5. **Enicnus minutus** (Linnaeus).
Linnaeus: Syst. Nat., 12th ed., p. 675, 1767 (*Tenebrio*).
Heller: Nova Caled. zool., vol. 2, pt. 3, p. 246, 1916.
New Caledonia: Paita. Cosmopolitan.

6. **Mumfordia monticola** Zimmerman, new species.
Society Islands: Tahiti.

7. **Mumfordia spinata** Van Dyke.
Van Dyke: B. P. Bishop Mus., Bull. 98, p. 237, fig. 52, *a*, 1932.
Marquesas: Hivaoa.

8. **Mumfordia tuberculata** Van Dyke.
Van Dyke: B. P. Bishop Mus., Bull. 98, p. 237, fig. 52, *b*, 1932.
Marquesas: Uahuka.

CORTICARIINI

9. **Corticaria longula** Broun.
Broun: New Zealand Inst., Bull. 1, p. 26, 1910.
Kermadec Islands: Sunday Island. New Zealand.

10. **Corticaria serrata** (Paykull).
Paykull: Fauna Suecica, vol. 1, p. 300, 1798 (*Dermestes*).
Heller: Nova Caled. zool., vol. 2, pt. 3, p. 246, 1916.
New Caledonia: Paita. Cosmopolitan.

11. **Melanopthalma antipodum** (Belon).
Belon: Révue d'Ent., vol. 4, p. 252, 1885 (*Corticarina*).
New Caledonia: Tongue.

12. **Melanopthalma fauveli** (Belon).
Belon: Révue d'Ent., vol. 4, p. 253, 1885 (*Bicava*).
New Caledonia: Mount Cogi.

13. **Melanopthalma setiger** (Belon).
Belon: Révue d'Ent., vol. 4, p. 251, 1885 (*Corticarina*).
New Caledonia: Mount Cogi.

NON-MARINE INVERTEBRATE FAUNA OF THE MARQUESAS

(EXCLUSIVE OF INSECTS)

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INTRODUCTION

In this review of the Marquesan terrestrial and fresh-water invertebrate fauna, exclusive of insects, I have summarized the results of the specialists who have studied the collections made in the Marquesas by the Pacific Entomological Survey. I have given special attention to the facts that concern problems of distribution, and to supplementing the taxonomic reports with observations made in the field.[1] It has not been possible, at present, to attempt to list all the species in each group of animals, because a fair number of additions will be made when all the collections have been determined. I have omitted, as far as possible, details that are to be found in systematic reports already published. The opinions expressed in these pages regarding the absence of records of any group of animals from oceanic[2] islands in the Pacific are based on an extensive, but not exhaustive, review of the literature; these opinions are therefore to be taken with the reservations that I have made at appropriate places in the text. The manuscript was written in 1933; it has been revised before going to press, but I have probably neglected not a few important papers on Pacific island faunas published since 1933.

I am indebted to Monsieur L. J. Bouge, Governor of the Etablissements français de l'Océanie at the time of my visit, for permission to work in the islands, and to Monsieur A. Aumont, then Administrator in the Marquesas, and his successor, Monsieur le Docteur

[1] As a member of the Pacific Entomological Survey Mr. A. M. Adamson resided in the Marquesas from January 21, 1929, to April 10, 1930. During this period he made collections on the islands of Hatutu, Eiao, Nukuhiva, Uahuka, Uapou, Hivaoa, and Mohotani. Enroute to the Marquesas Mr. Adamson collected insects on Tahiti and Moorea which have been described by specialists in a series of 31 papers (B. P. Bishop Mus., Bull. 113). The scope and activities of the Pacific Entomological Survey are recorded in the Reports of the Director of Bernice P. Bishop Museum for the years 1926-33.—Editor.

[2] The term "oceanic" is used in this paper to designate islands within the Pacific Depression, without reference to their origin.

Louis Rollin, for the hospitality and assistance graciously extended by them.

I am indebted also to Marquesans and other residents in the islands for information received from them, particularly regarding native names of animals. I wish to thank especially Père Siméon Delmas, Monsieur Zacharie Touahafeuu, Monsieur Timo Vahatetua, Monsieur Stanislas Taupotini, Mr. Robert MacKittrick, and most of all Monsieur G. LeBronnec. In preparing this review I have received much advice from Mr. O. H. Swezey, Dr. F. X. Williams, Dr. C. H. Edmondson, and Mr. R. H. Van Zwaluwenburg, and, concerning the Mollusca, from Dr. C. Montague Cooke, Jr., and Dr. H. A. Pilsbry.

GENERAL REMARKS

In the Marquesan non-marine fauna there are only two phyla, the Arthropoda and Mollusca, in which large numbers of endemic species are known. The Protozoa and the Trochelminthes of these islands have received scarcely any attention; it is possible that both phyla are represented by few, if any, endemic free-living species. The Porifera, Coelenterata, and Molluscoidea may be entirely unrepresented; an exhaustive search for them was not made, but fresh-water sponges and polyzoans, if at all common, would probably have been found. Hydra, if present, may easily have escaped notice. A few free-living terrestrial Platyhelminthes and Nemathelminthes were found, and a few parasitic species are known to occur. There may be some endemic species, both free-living and parasitic, in these two phyla. The Annulata are represented in the collections only by terrestrial Oligochaeta, which are probably all immigrants transported by man. Non-marine Polychaeta and Hirudinea may be entirely absent. Among the Arthropoda a few endemic species of terrestrial Crustacea are known, and a large number of endemic Insecta, Araneida, and free-living Acarina. Other arthropods are poorly represented or entirely absent. In the Mollusca there are numerous endemic species in a few ancient terrestrial families, and a very few species of fresh-water gastropods, all of which may be widely distributed.

The extreme paucity of the fresh-water faunas of Pacific oceanic islands is well known and the small number of aquatic species in the Marquesan collection is not surprising. But it should be stated that relatively little time was spent in collecting in streams. Even less

time was devoted to the few pools of stagnant water, almost all of which are found at low levels. This partial neglect of the fresh-water fauna was due to the fact that in the short time available general collecting was done chiefly by methods that gave the largest returns.

Some of the fresh-water species, such as the palaemonid prawns and the isopod *Ligia vitiensis,* have been derived fairly recently from marine forms and their dispersal to oceanic islands may perhaps be explained by their former marine habit. Others, such as the atyid shrimps and snails of the genus *Melania,* probably attained their present distribution in the Pacific islands after they had taken to fresh water. The occurrence of these species therefore presents about the same problem as the presence of terrestrial species. With allowance for the greater difficulty that fresh-water species must overcome in crossing the ocean, the endemic fresh-water fauna in the Marquesas is still remarkably meager in comparison with the terrestrial fauna. This applies even to the insects, though the aquatic forms are at least partially aerial in their adult phases.

A full discussion of the affinities of the fauna awaits the completion of systematic studies on the collections made by the Pacific Entomological Survey. But it is already evident that there is a general affinity between the Marquesan fauna and that of the islands to the southwest and in turn with the Indo-Malayan fauna. No direct affinity has been thus far discovered, in the invertebrates dealt with here, between the Marquesas and Hawaii, except in one genus of spiders and, according to Jacot (30),[3] in some of the mites. There is little evidence, also, of any influence from America.

PROTOZOA

Nothing appears to have been written on the free-living Protozoa of the Marquesas; no attempt was made to study them, except when making a few hauls for fresh-water plankton, at Vaihakameama, Nukuhiva, when a species of *Difflugia* (?) was the only protozoan that I saw.

The presence of pathogenic Protozoa in the Marquesas may be inferred from the occurrence of the diseases caused by them, of which an account is given by Rollin (40). Syphilis has probably been rampant in the islands since the arrival of the first white voyagers, though at present it appears to occur mostly in a hereditary form.

[3] Numbers in parentheses refer to Literature Cited, p. 37.

There have been disastrous epidemics of dysentery; after questioning residents in the islands, I was unable to decide whether these were of the bacillary or the amoebic form, or both. The absence of amoebic dysentery from most of the Pacific islands suggests that only the widespread bacillary form has occurred in the Marquesas. The depopulation of the Marquesas from more than 50,000 to about 2,000 has been due almost entirely to introduced diseases, especially tuberculosis, but a surprisingly small number of protozoan and other so-called tropical diseases have as yet reached the Marquesas and other islands east of Samoa. This is no doubt largely due to the absence of many insect vectors, such as anopheline mosquitoes.

It is unfortunate that time was not found for the preservation of flagellates from the Marquesan termites, of which three endemic species are known. The remaining four species, in the genus *Kalotermes* (*s. lat.*), are found in other parts of the central Pacific, and it would be interesting to know if each species has exactly the same flagellate fauna on each archipelago.

Little work has been done on the free-living Protozoa of any Pacific island, even Hawaii. Edmondson (18) observed 46 species in Tahiti, and notes that all of these are common in North America. Van Winkle (49) lists 49 species of testaceous rhizopods from Hawaii, none of which are new species.

PORIFERA

No fresh-water sponges were found in the Marquesas. It would be unwise to conclude on this evidence alone that none occur, but I have been unable to find records of any farther east than Fiji, where *Spongilla gilsoni* was described by Topsent (47). It is probable that fresh-water sponges have failed to reach the oceanic islands of the Pacific.

COELENTERATA

Hydra might be expected to occur in the Marquesas; I observed none, but looked for them only a few times. I have found no records of fresh-water coelenterates from the oceanic islands of the Pacific. Mr. O. H. Swezey and Dr. C. H. Edmondson, however, tell me that Hydra is to be found in Honolulu; so far as I know its presence in Hawaii has not been recorded in the literature.

PLATYHELMINTHES

TURBELLARIA

A few terrestrial planarians were collected at altitudes of 1,720 to 3,900 feet on Hivaoa, Nukuhiva, and Uahuka. They were observed frequently, but in small numbers, among wet vegetation, mostly in the cloud zone, and I suspect that they are limited to high altitudes. The specimens have not yet been identified; they appear to represent a single species. New Caledonia (42) has a large number of endemic land planarians. *Bipalium kewense,* now widespread, is native in Fiji, Tonga, and Samoa, and so far as I have been able to discover, this is the only land planarian which has been identified on the Pacific islands east of Fiji. I have seen at least one unidentified species in the forests of Hawaii.

I spent some time looking for fresh-water planarians in the Marquesas, without success. A search in the literature on the Pacific islands proved equally fruitless, but Dr. F. X. Williams tells me that he has observed at least two small species in streams at medium altitudes near Honolulu.

TREMATODA

We learned nothing regarding the occurrence of trematodes in the Marquesas, except in a communication from Dr. Louis Rollin, formerly Administrator of the islands. In a remarkable case of haemoptysis, he found in the patient's sputum eggs which resembled those of the lung-fluke *Paragoninus westermanni* Braun. In view of the paucity of endemic mammals and fresh-water fishes, few species of trematodes of special interest are likely to occur on the oceanic islands of the Pacific, and I know of no records beyond those of widespread species, such as *Fasciola hepatica.*

CESTODA

No tapeworms have been reported from the Marquesas. As with the trematodes, few species are likely to occur on oceanic islands, but *Drepanidotaenia hemignathi* Shipley and another, undetermined, species are known from drepanid birds of Hawaii, and interesting species may occur in the endemic birds of the Marquesas.

NEMERTINEA

No non-marine nemerteans are known in the Marquesas, nor, so far as I know, in any central Pacific island east of Samoa. There are some terrestrial species in Samoa (26). Buxton (7) writes that

Geonemertes palaensis, recorded also from Palau and Celebes, is common in the Samoan forests.

NEMATHELMINTHES

NEMATODA

The nematode worms of the Marquesas have so far received little attention, and specific, authoritative records seem to be entirely lacking. Nothing appears to have been written on free-living species. I have records of a few specimens in wet humus at about 4,000 feet altitude on Temetiu, Hivaoa, and it is likely that many species of free-living nematodes occur in the Marquesas. Numerous species have been described from the soil in Hawaii and a few other archipelagoes, but the distribution of these worms throughout the Pacific is too little known for the drawing of any conclusions regarding their origin and geographical relations.

An interesting and somewhat surprising find was that of the small worm, *Rhabditis coarctata* Leuckart, attached in large numbers to caterpillars tenatively referred to the family Gelechiidae. The worms were kindly identified by Dr. J. N. Oldham. They have been found in other parts of the world on scarabaeid and staphylinid beetles; the larval worms attach themselves to the surface of the beetles, encyst there, and are carried to fresh supplies of dung on which the worms feed (48, 50). The Marquesan specimens were found at Atuona, Hivaoa, and on Fatuhiva, on caterpillars boring in the large seeds of the Tahitian chestnut (*Inocarpus edulis*). Unfortunately, moths reared from these were lost. The caterpillars appear to belong to the family Gelechiidae, and they have been noticed within the last few years in the Marquesas, as a pest infesting almost every seed of the Tahitian chestnut in certain places. The origin of the worms in the Marquesas is a matter for speculation: they may have come with the caterpillars or other insects, or independently in dung of domestic animals. Dr. Oldham tells me that *Rhabditis coarctata* has hitherto been recorded only as a dung form, and he raises the question as to whether the caterpillars on which they were found in the Marquesas were likely to come in contact with dung. Unfortunately I do not know whether the caterpillars ever spend time outside the fruits, on the ground; but at Atuona, Hivaoa, it is possible that horses may have been tethered under the tree below which the infested fruits were found, so that contact with dung seems not unlikely.

A few parasitic nematodes are known in the Marquesas.

Marquesan children are said to be frequently infected by two species of intestinal worms. The smaller worm (*kaio* or *naio*) is probably *Enterobius vermicularis* (Linnaeus), and the larger (*potiveo*) is probably *Ascaris lumbricoides* Linnaeus. Native remedies are extracts of the bark of the banyan (*Ficus prolixa*) and of the flowers of *Gardenia tahitensis.*

Elephantiasis is common among the Marquesans, and a few white residents suffer from it. It is believed locally to have been introduced to the Marquesas about 1895 by Tahitian convicts sent to Uahuka. *Filaria bancrofti* Cobbold is probably the species concerned, as in other parts of Polynesia, and it is doubtless transmitted by one or both of the species of mosquito—*Culex fatigans* Wiedmann and *Aedes scutellaris* Walker—known to occur in the Marquesas. I have found no extensive account of filariasis in French Polynesia; a great deal of information on the disease and the rôle of mosquitoes in its transmission in Samoa and other parts of the Pacific is given by Buxton and Hopkins (8).

Acanthocephala

No worms of the class Acanthocephala are known from the Marquesas. It is possible that there are endemic forms, though in the oceanic islands of the Pacific the only endemic species I know of is the remarkable *Apororhynchus hemignathi* Shipley from the Hawaiian drepanid bird, *Hemignathus.*

Trochelminthes

A few rotifers were collected in Vaihakameama pond on Nukuhiva, at about 2,600 feet. They have not yet been identified. The most important reference to fresh-water rotifers in the oceanic islands of the Pacific is a paper by Murray (35), in which he lists 24 widely distributed species from Hawaii, 2 from Samoa, 15 from Fiji, and 2 from the Galapagos, as well as an unnamed "evidently distinct" species from Hawaii.

I know of no records of Gastrothricha from the Pacific islands.

Molluscoidea

Polyzoa

Fresh-water polyzoans were not observed in the Marquesas, but only a short time was devoted to searching for them. The only records I have found in the Pacific islands are from Tahiti, where

two species were collected by Dr. Cyril Crossland in Lake Vaihiria, at an altitude of 1,140 feet. These were recorded by Hastings (24), one of them as a new species, *Hyalina vaihiriae*. The other, which I also found in the same locality, was assigned to the cosmopolitan *Plumatella emarginata* Allman, but Dr. Hastings informs me that revision of this species may eliminate the Tahitian forms from it. In a fresh-water fauna so small as that of Tahiti, it is perhaps surprising that at least one endemic polyzoan occurs.

ANNULATA

All of the non-marine annelids observed in the Marquesas were terrestrial oligochaetes.

So few fresh-water polychaetes are known that it is likely that none occurs in the Marquesas. A fresh-water nereid was described, as *Lycastis hawaiiensis,* by Johnson (32) from a spring near Honolulu, and from another, unrecorded, locality in Hawaii. Its occurrence is probably of no significance in connection with the true fresh-water fauna.

It is not improbable that leeches occur in the Marquesas, though none was found. Dordillon (16) gives the Marquesan name *toke omo toto* (blood-sucking worm) for leech, but this can hardly be accepted as evidence of anything except possibly a recent introduction. *Philaemon minutus* Blanchard is endemic in Samoa, in the wet mountain forests (7). In Hawaii the fresh-water leeches have not been studied; Bryan (9) states that two unidentified species are quite common in the streams of Oahu.

Oligochaeta (earthworms) occur at all altitudes in the Marquesas. In the rain forest they are to be found in small numbers in wet, decaying vegetation, under moss on tree trunks, and under stones. The soil fauna in the mountains was not investigated. The collection, which appears to include a small number of species, has not yet been identified.

The oligochaetes are of special interest in problems of zoogeography, but those of oceanic islands serve only, in the absence of endemic species, as evidence that the islands are truly oceanic. This absence may be regarded as well established, on the recent and authoritative statement of Stephenson (46, p. 674), who attributed the presence of earthworms on oceanic islands entirely to human

traffic. It is therefore to be expected that all the species in the Marquesas will be found to be immigrants of wide distribution.

The Marquesan name for earthworm is *toke,* with its variants *to'e* and *toketoke.* The mention of them in legends may indicate only that earthworms probably reached these islands along with food plants brought by the Polynesians.

ARTHROPODA

With the exception of the Onchyphora, all the classes of arthropods—if the myriopods be regarded as one class—are represented in the non-marine fauna of the Marquesas. The myriopod fauna is restricted and endemic species have not yet been recorded. In the Crustacea very few endemic species are known so far; all these are terrestrial, in the orders Isopoda and Amphipoda; the few aquatic malacostracans are decapods of wide distribution. The insects are, of course, the largest class in the fauna. The endemic arachnids are limited to spiders and Acarina, both of which are well represented, and pseudoscorpions; a single introduced scorpion is present and all other orders of arachnids appear to be absent.

The absence of the Onychophora is to be expected. No named species of this class has been recorded in the Pacific east of New Britain, where *Paraperipatus novae-brittaniae* (Willey) occurs, though Clark (12) states that "unidentified species, which were not preserved, have been met with in the Philippines and in Fiji."

No special attempt was made to collect Tardigrada, which are probably present. In a very short time Murray (34) was able to collect no less than 16 species in Hawaii; but none of them were regarded by him as endemic, the fauna being a heterogeneous assemblage of widespread species. An endemic species, *Macrobiotus samoanus* Richters, has been recorded from Samoa, and it is possible that many other endemic species may occur in the mountains of the Pacific islands; so far as I know, a search for them has scarcely ever been made.

No attempt was made to find members of the aberrant, parasitic order Pentastomida in the Marquesas. The vertebrate fauna is so limited that few, if any, are to be expected.

CRUSTACEA

The non-marine crustacean fauna of the Marquesas is as limited as might be expected. Aquatic species in the collections include a

few copepods, one species of the ostracod genus *Cypretta,* a semi-aquatic *Ligia,* and six widely distributed species of decapods in the families Atyidae and Palaemonidae. The terrestrial species are of considerable interest, including two endemic genera of isopods and some amphipods in the family Talitricidae.

This limited fauna presents the same general features as that of Hawaii, to which the above paragraph might be applied with few changes. The non-marine crustacean faunas of other Polynesian islands also, so far as I know, differ in few essential features.

Entomostraca

Some branchipods may occur in the Marquesas, but possibly without endemic representatives. Only a few widespread species appear to have been recorded from the Pacific islands. It is interesting to note that *Artemia salina* (Linnaeus) has reached Hawaii (41) and that an undetermined species of *Apus,* of which specimens are preserved at the Experiment Station of the Hawaiian Sugar Planters' Association, appeared on Oahu in 1932.

Cladocera also probably occur, though very few—and none of them endemic—appear to have been reported from central Pacific islands.

Ostracoda

The one species of ostracod known in the Marquesas was described by Furtos (21) as *Cypretta nukuhivana.* I found it in abundance in collecting plankton in a small pond, known as Vaihakameama, in western Tovii, Nukuhiva. I think that this pond is temporary, though it is the largest body of stagnant water that we found in the high interior of the Marquesas Islands. Only females were collected, and Furtos writes that males, which are rarely found in this genus, probably never occur in this species, reproduction being presumably always parthenogenetic. The genus *Cypretta* is represented in almost all the geographical regions. It is likely that other species of ostracods occur in the Marquesas; habitats suitable for them are not numerous, and even these were not exhaustively searched by us, but I am surprised that this order was found only once.

No endemic ostracods appear to have been reported from fresh water in any oceanic island in the Pacific with the exception of this

Marquesan species, which may not prove to be peculiar to the Marquesas.

Copepoda

In a sample of plankton from Vaihakameama there were numerous small copepods, which have not yet been determined. Very few fresh-water copepods have been recorded from the Pacific islands, and most of these are species of wide distribution.

MALACOSTRACA

Amphipoda

Three species of amphipods were collected in the Marquesas, as reported by Stephensen (45): *Orchestia floresiana* Weber, including the new form *monospina* Stephensen, *O. marquesana* Stephensen described as new, and *Talitrus sylvaticus* Haswell. All are terrestrial species, of the family Talitridae, and they are common among wet vegetation, both on the ground and on mossy branches of trees, on the six larger islands. None were observed on the lower, uninhabited islands, where the climate is probably too dry.

Orchestia floresiana is the commonest species in the Marquesas. It was found on all the six inhabited islands, at altitudes of about 1,000 to 4,000 feet. Though it seems to be characteristic of the mountain forests, it is probably at home wherever there is a permanent habitat of wet or damp vegetation. Three specimens, two from 3,300 feet on Uapou and one from 2,900 feet on Uahuka, belong to the new form, *monospina*. *Orchestia marquesana* also was found in considerable numbers, but only at high altitudes, and only on the central islands: Nukuhiva (2,000-4,000 feet), Uapou (2,700-3,300 feet), and Uahuka (1,820-2,900 feet). It may occur on the southeastern islands, but it would probably have been collected there if it were as abundant as it is on the other islands. *Talitrus sylvaticus* is probably the least common of the three species, being collected only once on Uapou and twice on Hivaoa (about 2,000 feet), and many times on Fatuhiva (600-1,700 feet), which is the wettest island in the Marquesas.

An exhaustive search for aquatic species was not made, but I spent a fair amount of time in looking for amphipods in the mountain streams. Less time was spent at low levels, but it is surprising to read in Jardin's account of the Marquesas fauna (31): " . . . dans les Amphipodes, les genres *Talitrus* et *Gammarus* (nom ind. *koua*)

qu'on trouve en abundance dans tous les cours d'eau". I do not know how to account for this discrepancy between Jardin's observations and mine.

I have found no references to strictly fresh-water amphipods in the Pacific oceanic islands, and to only a few terrestrial species, all of which belong to this family, the Talitricidae.

The non-marine Marquesan amphipods present the same general features of those of other central Pacific islands, with a limited number of the Talitridae, including a small endemic element, and a few species ranging across the Pacific, some of them as far as islands of the Indian Ocean. Of the Marquesan species, *Talitrus sylvaticus* is known also in Hawaii, Australia, and Tasmania, and *Orchestia floresiana* in the Seychelles, Malay, and Melanesia. Skottsberg's "Old Pacific" element may be represented in the terrestrial amphipods of the central Pacific, since the genus *Parorchestia,* according to Chevreux (11), occurs in Hawaii, New Zealand, and the subantarctic islands.

ISOPODA

A report on the greater part of the Marquesan collection of Isopods by H. G. Jackson (28) includes 12 terrestrial species in the family Oscinidae, and one semi-aquatic species of the Ligiidae. The collection is fairly representative, since most of the habitats of these animals were explored, but as one of the endemic species was found only once and the other twice it is likely that several other endemic species are yet to be discovered. No strictly aquatic species were seen in the streams; the time spent in searching for them was limited.

Ligiidae

Ligia vitiensis Dana—known also from Fiji and New Guinea—was taken at a single locality and, oddly enough, on the relatively dry island of Eiao, where several specimens were found running about on the face of a small cliff, at about 200 yards upstream in Vaituha Valley. It seems unlikely that this species should be restricted to a single island in the Marquesas, but in the habitat in which it was found on Eiao it is very conspicuous and unlikely to escape notice. It seems reasonable to suppose that it has been derived directly from a marine form, and its occurrence may have no bearing on the origin of the truly non-marine fauna.

OSCINIDAE

The members of the family Oscinidae form an interesting assemblage, well represented in the fauna at all altitudes and on all the islands. At low levels, the cosmopolitan wood louse *Porcellio pruinosus* Brandt and the pill bug *Cubaris murinus* Verhoeff are abundant. *Alloniscus oahuensis* Budde-Lund was found at low levels less frequently than these, as well as *Philoscia truncata* Dollfus and *Porcellio laevis* Latreille. *Philoscia fasciata* Jackson is the commonest isopod in the Marquesas. It is found wherever there is moist vegetation, on the ground and on trees and ferns, and it is therefore most abundant in the rain forest above 2,000 feet, though occurring down nearly to sea level. The other members of the cloud-zone fauna are rare species of the subfamily Armadillinae: *Spherillo montivagus* Budde-Lund, taken on Hivaoa, Uahuka, and Uapou between 2,000 and 3,000 feet; *S. testudinalis* Budde-Lund only once, on the summit of Ooumu at about 4,000 feet; *S. pygmaeus* Verhoeff, which, curiously enough, was taken once near sea level and once on Ooumu at 4,000 feet; *S. marquesarum* Jackson, found on Uapou at 2,000 and 2,700 feet; and two spinose species, in endemic genera, *Echinodillo montanum* Jackson and *Tridentodillo squamosus* Jackson, which were found respectively at 2,900 feet on Uahuka, and at nearly 4,000 feet on Nukuhiva.

The most significant features in the distribution of the Marquesan isopods are the presence of an endemic element, which will probably be found, after further collecting, to be larger than is now known; and the close affinity with the Society Islands and other groups to the southwest. The isopod faunas of all of these islands show a similarity in the preponderance of the subfamily Armadillinae among the endemic species.

There is a well-marked restriction, in greater or less degree, of the cosmopolitan and other very widely distributed species to low levels in the Marquesas, and of the endemic species, and those confined to Polynesia, to high altitudes.

There is little to be learned from the isopods, as now known, regarding the relations between the individual islands in the Marquesas. Apart from the cosmopolitan species and *Ligia vitiensis*, Nukuhiva and Uahuka have 5 species each, Hivaoa 4, Fatuhiva 3, Uapou 2, and Tahuata 1, but these differences may be due to chance

as much as other factors. The lower, uninhabited islands have only a few species of very wide distribution.

The Marquesan name for terrestrial isopods is *hotuhotu*; Dordillon (16) gives the following surprising translation for this term: "petits vers noirs qui rongent le bois; fourmilier; vers qui rongent les cadavres."

DECAPODA

The decapods have been identified by Dr. C. H. Edmondson, of Bernice P. Bishop Museum. He has kindly allowed me to make use of his determinations, as well as of information regarding their distribution. Two families are represented in the Marquesan streams, the Atyidae and Palaemonidae.

ATYIDAE

Caridina weberi de Man.

Taiohae Valley (1,200 feet), Nukuhiva, Omoa Valley (300 feet), Fatuhiva, and Hakahetau Valley (325 feet), Uapou, 18 specimens. Though less commonly found than others of this family, this species is probably present on almost all the islands in the Marquesas. Its known distribution includes Sumatra, Java, Celebes, and Flores, and its presence in other Pacific islands besides the Marquesas is to be expected.

Atya serrata Spence Bate.

Atuona Valley (800 feet), Hivaoa, Omoa Valley (300-1,600 feet), Fatuhiva, Taiohae Valley (1,200 feet), Nukuhiva, Hakahetau Valley (325 feet), Uapou, and Vaituha Valley (200 feet), Eiao, 257 specimens. This form has been recorded from Madagascar, Reunion, Mauritius, the Solomon Islands, the Marianas, Fiji, Samoa, and Tahiti.

Ortmannia alluaudi Bouvier.

Omoa Valley, Fatuhiva (300-1,600 feet), and Vaituha Valley (200 feet), Eiao, 101 specimens taken in company with *Atya serrata*. The distribution of this species is parallel to that of *Atya serrata*.

Edmondson considers it likely that *Atya serrata* and *Ortmannia alluaudi* represent a single plastic species, in a relation similar to the remarkably interesting case of *Atya bisulcata* Stimpson and *Ortmannia henshawi* Rathbun in Hawaii, as discovered by him (17). The

form *Atya* in the Marquesas seems to be a mutation of the more basic form *Ortmannia.*

Several Marquesan names were given for specimens of this family. Probably some of them were used with little precision and discrimination as to species: *pinau* (Nukuhiva, Uapou), *moke* (Fatuhiva), *koua tai* (Uapou), *oupapa* (Fatuhiva), *koua nipuu* (Hivaoa). Variants of *nipuu* are *hipuu* and *ipuu.*

Each of these three species is probably present on all of the islands except Hatutu and Fatuuku, though none of them were taken on Mohotani.

PALAEMONIDAE

Three species of fresh-water prawns are abundant throughout the Marquesas.

Palaemon lar Fabricius.

On the inhabited islands and also on Eiao 450 specimens were collected as follows: Atuona and Papuaei Valleys, Hivaoa; Vaitahu Valley, Tahuata; Omoa Valley (15 and 150 feet), Fatuhiva; Taiohae Valley (1,200 feet) and Pakiu Valley (150 feet), Nukuhiva; Hakahetau Valley (1,000 feet), Uapou; Vaikivi Valley (1,400 feet), Uahuka; Vaituha Valley (200 feet), Eiao. The specimens from Vaikivi Valley, Uahuka, are much larger than those from other islands, and the Marquesans believe that these differences are constant. The distribution of this species is very wide, from Madagascar through the Indo-Pacific region as far as Mangareva.

Palaemon dispar von Martens.

Omoa Valley (6, 10, 15, and 300 feet), Fatuhiva, Vaitumata Valley, Hivaoa, and Hakahetau Valley (325 feet), Uapou, 263 specimens. The species is probably present on other islands. Its distribution is nearly as wide as that of *P. lar,* including Reunion, Mauritius, Rodriguez, Tandjong, Amboina, and Samoa.

Palaemon latimanus von Martens.

Atuona Valley, Hivaoa, Vaitupaahei Valley (1,750 feet), Tahuata, Omoa Valley (1,700 feet), Fatuhiva, Taiohae Valley (1,200 feet), Uapou, and Mohotani (1,270 feet), 294 specimens. This species more than the two others seems to prefer the cooler streams of high altitudes, though it is not restricted to them. It

has been reported from islands in the Malay Archipelago, the Philippines, Fiji, Samoa, and Tahiti.

The general Marquesan term for shrimps and prawns of all kinds is *koua.* The three species of *Palaemon* are known by many names, according to locality and to size, sex and maturity. The following were recorded by us, the prefix *koua* being omitted: for *P. lar*: *paeho* (Nukuhiva), *hetou* (female, Nukuhiva), *tipu* (young, Nukuhiva), *akae* (Fatuhiva), *hakae* (Uapou); for *P. dispar*: *ainehu* and *akae* (?) (Fatuhiva); for *P. latimanus*: *kaipinata* (Hivaoa), *aipinata* (Fatuhiva), *vaeaei* (Nukuhiva and Uapou). The terms *pinau* and *nipuu* were sometimes given to small specimens of *Palaemon,* but they probably apply strictly only to the Atyidae.

These prawns are caught by the Marquesans with nets and spears, usually with a light at night. The first food given to new-born infants is said to have been made by crushing prawns with stone pounders, a special kind of pounder being reserved for this use.

The origin of the Atyidae and Palaemonidae on oceanic islands presents an extremely interesting problem. Edmondson (17) points out that Atyidae is one of the most ancient families of fresh-water decapods, and finds no explanation for its dispersal to oceanic islands. Buxton (7) writes of the Atyidae: "These prawns, as Dr. W. T. Calman tells me, are doubtless a true and ancient fresh-water group. But the genus [*Caridina*] and some of the species are so widely spread, that he is tempted to suppose that they must at times enter the sea. In any case their distribution is anomalous, and does not appear to throw any light on our problem."

Many of the Palaemonidae ascend from the sea into brackish water, and the three species in the Marquesan streams may owe their very wide distribution to a former marine habit.

The coconut crab (*Birgus latro* Linnaeus) has been reported from the Marquesas (27). Residents in the islands assured us that it does not occur there. Edmondson suggests that it may have been exterminated by the Marquesans. A large land crab (Marquesan name, *tupa*) is common in many parts of the islands, especially on the deltaic flats at the mouths of the valleys. These species are scarcely to be considered as members of the non-marine fauna.

MYRIOPODA

Thirteen species of myriopods collected in the Marquesas have been identified by Dr. Filippo Silvestri (43; 1). The myriopods received as much attention in collecting as any group of arthropods, and the methods employed appear to cover fairly well the habitats of these animals, with the exception of subterranean species. It is therefore surprising that no endemic species were found. Of the thirteen species, seven are widely distributed throughout the tropics. Of the others, *Trigoniulus naresii* is found as far from the Marquesas as Madagascar, *Hypocambala anguina* as far as the Seychelles, *Mecistocephalus tahitiensis* and *Hanseniella orientalis* as far as Australia, *Cryptops niuensis* as far as the Solomon Islands, and *Cryptops notandus* is known only from the Marquesas and Samoa. It is possible, though unlikely, that no endemic species have been evolved in the Marquesas. The Hawaiian endemic fauna is restricted to a few genera, only one of which—*Dimerogonus*—has developed more than one described species. In Samoa only one endemic species is known. On the other hand, two endemic species of *Cryptops* and one each of *Mecistocephalus* and *Trigoniulus* have been found in Tahiti, where comparatively little collecting has been done. So far as I know, only wide-ranging species of the Symphyla and Pauropoda have been found on central Pacific islands: *Hanseniella orientalis* in the Marquesas and Samoa, and presumably introduced species of *Scutigerella, Scolopendrella,* and *Pauropus* in Hawaii (51). The Marquesan myriopods, so far as known, were clearly derived from the southwest.

CHILOPODA

SCOLOPENDRIDAE

Scolopendra subspinipes Leach is very abundant throughout the Marquesas, having failed, apparently, to reach only two of the smallest islands, Hatutu and Fatuuku. It is a fairly recent introduction and has largely replaced *S. morsitans* Linnaeus, which is an ancient immigrant, probably arriving with the Polynesians themselves; *S. morsitans* is now restricted to fairly high altitudes on the higher islands, and to the uninhabited and inaccessible lower islands.

Cryptops niuensis Chamberlin was found under dead bark and in dead fern stalks at altitudes above 2,000 feet on all the inhabited islands except Fatuhiva, and also on Mohotani. *Cryptops notandus,*

described by Silvestri (43) from the Marquesas, and collected by him in Samoa, was found at 750 and 2,970 feet on Uahuka.

ORYIDAE

A single species, *Orphnaeus brevilabiatus* (Newport), was found in small numbers at low and intermediate altitudes. It was collected on five of the islands, but it is probably present on all.

MECISTOCEPHALIDAE

Mecistocephalus tahitiensis H. F. Wood and *M. maxillaris* Gervais are common throughout the Marquesas, at all altitudes, though most frequently collected in the mountain forests. They were never found in large numbers, but only singly or in groups of two or three.

The Marquesan name for centipede is *ve'i*: *Scolopendra morsitans* is named *ve'i enata* or *ve'i mao'i* (native centipede); *S. subspinipes* is *ve'i papa'a,* from the Tahitian for "foreign". The small species are known as *ve'i puaina* (Fatuhiva), *ve'i u'upuaina* (Fatuhiva and Tahuata), *ve'i iaufenua* (Fatuhiva), and *ve'i ka'opuaina* (Uapou), probably without distinction of the species.

SYMPHYLA

SCUTIGERELLIDAE

Hanseniella orientalis (Hansen) was collected only twice, at 2,500 feet on Hivaoa and at 450 feet on Fatuhiva.

DIPLOPODA

POLYDESMIDAE

Orthomorpha coarctata (Saussure) and *O. gracilis* Koch are very abundant throughout the six higher islands, in all regions, except where it is very dry, from sea level up to about 3,000 feet. *Cylindrodesmus hirsutus* Pocock was found only a few times, at low altitudes on Fatuhiva, Uahuka, and Eiao.

TRIGONIULIDAE

Trigoniulus naresii Pocock, like the two polydesmids, is very abundant, in all regions that are not too dry, from sea level up to about 2,000 feet.

CAMBALIDAE

Hypocambala anguina (Attems) was collected a few times, once at 1,500 feet but more often at nearly 3,000 feet or higher, on Hivaoa, Nukuhiva, and Uahuka.

Millipedes are known by the modern term *ve'i kina* (Chinese centipede).

ARACHNIDA

Of the nine orders of existing non-marine Arachnida, four—the Scorpionida, Chelonethida, Araneida, and Acarina—are represented in our collections from the Marquesas. Of these the Scorpionida are to be excluded from the native fauna. The absence of the remaining orders from our collections is not surprising, in view of their meager representation or absence on other oceanic islands in the Pacific.

The Microthelyphonida are so little known that no conclusions regarding their distribution in the Pacific islands should be made. But it is interesting to note that one species of *Koenenia* has been found in Hawaii by Van Zwaluwenburg (51) in soil at low levels.

The Pedipalpi do not seem to have been found in the Pacific farther east than Samoa (33).

The small order Ricinulei, according to Ewing (19), is known only from Africa and South and Central America.

Of the Solpugida I have found no records at all from oceanic islands in the Pacific.

The Phalangida have a few endemic species in Melanesia. *Zalmoxis savesi* (Simon) occurs in Samoa, as well as in Melanesian islands, but not even immigrants seem to have gone farther east.

The Marquesan arachnid fauna, with regard to the presence or absence of the several orders, is very similar to that of the Hawaiian and other islands in the central Pacific.

SCORPIONIDA

The widely distributed *Isometrus europacus* (Linnaeus) (*I. maculatus* de Geer) was found near villages on Hivaoa, Tahuata, Nukuhiva, and Uapou, and is probably present on all of the inhabited islands. Its Marquesan name *koropio* is derived from the French *scorpion,* and it is regarded locally as an immigrant, probably from Tahiti, of not much more than 50 years standing.

It is unlikely that other scorpions occur. The same species, *I. europaeus,* is the only one known in Hawaii, and in the Society Islands and Samoa the only other is the widespread *Hormurus australasiae* (Fabricius), which I found in abundance in the forests at low levels on Tahiti and Moorea. I have found no records of scorpions endemic to any Pacific island farther east than New Cale-

donia, where two endemic species of *Hormurus* occur. It would therefore appear that the scorpions have not reached the oceanic islands of the Pacific except as recent immigrants, which is surprising for so ancient an order.

Pseudoscorpionida

Pseudoscorpions were found occasionally, and usually singly, in many types of country in the Marquesas, from low levels to some of the highest collecting grounds. They were taken in the course of general field work, no special search ever being made for them. Chamberlin (10) finds that three undescribed species are represented in the collection, belonging to three families and three genera: *Geogarypus,* in the family Garypidae, collected at intermediate levels on Hivaoa, Nukuhiva, and Uahuka; *Lamprochernes,* in the Chernitidae, of which adults were found at about 3,000 feet on Uapou, and immature forms, probably of the same species, at about 4,000 feet on Hivaoa; and *Oratemnus,* in the Atemnidae, from Eiao and Hatutu. All three species, being undescribed, may be endemic, though future collectors may find one or more of them elsewhere, for example in the Society Islands. It is probable that other species occur in the Marquesas.

A few endemic pseudoscorpions are known from most groups of oceanic islands in the Pacific. They appear to be a somewhat heterogeneous assemblage, probably because the order has received little attention from collectors. I am not prepared to discuss their relation to problems of distribution in the Pacific.

Araneida

The spiders are an important element in the Marquesan fauna at all altitudes, and the collections made are as representative as those of most other groups of animals, particularly at high altitudes. A careful study of the collections has been made by Berland (3, 4) who records 48 species, in 32 genera and 14 families. In the following list, taken from Berland (4, p. 36), all the species described by him are known only from the Marquesas, and all those followed by the names of other authors have been found elsewhere:

Dysderidae: Ariadna lebronneci Berland.
Sicariidae: Scytodes striatipes L. Koch, Scytodes marmorata L. Koch.
Oonopidae: Gamasomorpha loricata L. Koch.
Drassidae: Poecilochroa rollini Berland.

Thomisidae: Misumenops delmasi Berland.

Clubionidae: Corinna cetrata Simon, Clubiona alveolata L. Koch.

Sparassidae: Heteropoda regia Fabricius, Heteropoda nobilis L. Koch.

Salticidae: Bavia aericeps Simon, Plexippus paykulli Audouin, Menemerus bivittatus Dufour, Mollica microphthalma L. Koch, Thorellia ensifera Thorell, Athamas whitmeei Cambridge, Sandalodes calvus Simon, Sandalodes triangulifer Berland, Sandalodes nigrolineatus Berland, Sandalodes flavipes Berland, Sandalodes nigrescens Berland, Sandalodes magnus Berland.

Pholcidae: Physocyclus gibbosus Taczanowsky, Smeringopus elongatus Vinson, Pholcus ancoralis L. Koch.

Theridiidae: Theridion rufipes Lucas, Theridion fatuhivaensis Berland, Theridion mendozae Berland, Theridion 7-punctatum Berland.

Argiopidae: Uapou maculata Berland, Hivaoa argenteoguttata Berland, Hivaoa nigromaculata (Berland), Hivaoa hirsutissima Berland, Uahuka spinifrons Berland, Uahuka affinis Berland, Ischnyphantes pacificanus Berland, Leptyphantes lebronneci Berland, Leucauge mendanai Berland, Tetragnatha nitens Audouin, Tetragnatha macilenta L. Koch, Tetragnatha marquesiana Berland, Cyclosa tauraai Berland, Araneus theisi Walckenaer, Araneus plebejus L. Koch.

Pisauridae: Nukuhiva adamsoni (Berland), Dolomedes noukhaiva Walckenaer.

Uloboridae: Uloborus geniculatus Olivier.

Dictynidae: Syrorisa mumfordi Berland.

The 48 species are divided by Berland into three groups: endemic, 25; "Polynesian", 14; and cosmopolitan, 9. Four genera—*Uapou, Hivaoa, Uahuka,* and *Nukuhiva*—named by Berland (4) after Marquesan islands, and unknown elsewhere, are presumably endemic.

Most of the endemic species were taken quite rarely. The most abundant species in the mountains is the endemic *Misumenops delmasi,* a light-green spider which very frequently fell into the net used in beating for insects. Salticids were commonly seen at all altitudes, but almost always belonging to *Sandalodes calvus,* a species that occurs also in Tahiti and Australia. After *Misumenops delmasi,* the commonest endemic species found was the argiopid *Leucauge mendanai.* At low levels the commonest species taken was the cosmopolitan *Araneus theisi; Heteropoda regia* and *H. nobilis* also are abundant.

The endemic species are mostly restricted to high altitudes. Only four—*Poecilochroa rollini, Misumenops delmasi, Sandalodes magnus,* and *Syrorisa mumfordi*—were ever found below 1,500 feet and most of them were not seen below 2,000 feet. The Polynesian species also were mostly found in the mountains, and the cosmopolitan species as a whole belong to low levels.

The distribution of the endemic species throughout the Mar-

quesas is fairly uniform, with allowance for differences in size and topography of the individual islands. On each of the six larger, inhabited islands at least four endemic species were collected, but only one on Eiao—*Poecilochroa rollini,* found only on Eiao—and one on Hatutu—*Misumenops delmasi,* which is abundant in the inhabited islands. No spiders endemic to the Marquesas were found on Mohotani and Fatuuku, where the fauna in general is largely of widespread species. The distribution of the spiders in the Marquesas is thus in harmony with what is known about the distribution of other animals, and about the geological history of the islands.

In the spiders there is perhaps no island endemism within the Marquesas. This is made clear by Berland (4), who gives lists of six endemic species that have been found on three to six islands, and of seven on two islands. This leaves eleven species that have been collected on only one island, but as Berland points out the distribution of these species is as yet little known. Absence of island endemism is generally regarded as evidence of comparative youth of the islands as separate individuals, and the distribution of the spiders within the Marquesas points clearly in this direction, though the high degree of island endemism in certain other groups of animals—notably some beetles and the fulgoroid leafhoppers—points equally clearly to the opposite conclusion.

The spider fauna of the Marquesas is rather heterogeneous, there being only 3 genera with more than 2 endemic species—5 in *Sandalodes,* 3 in *Theridion,* 3 in *Hivaoa*—the remaining 14 endemic species being divided among 12 genera and 6 families. The heterogeneity in the non-endemic fauna is of course even greater.

Other general features of the Marquesan spider fauna have been fully set forth by Berland (3, 4), and need only be briefly summarized in this review.

The Mygaloidea, Agelenidae, and Lycosidae are the only large groups of spiders unrepresented in the Marquesan collections. There is a considerable development of endemic species in only three families, the Salticidae, Theridiidae, and especially the Argiopidae.

The Marquesan fauna, with 48 species as yet known, is considerably less rich than that of Samoa, with more than 80, and of Hawaii with more than 100. The degree of endemism among indigenous species in the Marquesas is 52 percent, against over 60 in Samoa and well over 70 in Hawaii. The 30 species, 7 of which are

endemic, recorded from the Society Islands by Berland (5), represent too small a portion of the total fauna to be considered in this comparison.

Berland's table (3) comparing the spiders of the Marquesas, Hawaii, and Samoa shows the similarity of the faunas with respect to the development in the several families. The exceptions are the relatively large numbers of Thomisidae and Lycosidae in Hawaii alone, and of the Clubionidae and Uloboridae in Samoa. The spiders of the Society Islands, as now known (5), show no special development in any family that is not well represented in these other islands.

Berland (3) states that the affinities of the Marquesan spiders are with those of the Society Islands, Samoa, and Tonga, and that all these islands, as well as Hawaii, have received their faunistic elements from Malaysia. Affinities with Australia and New Caledonia are very feeble. There is no affinity with America. In his second report on Marquesan spiders (4) he writes that the agriopid genera described from these islands—*Hivaoa, Uapou,* and *Uahuka*—belong to a group of small spiders represented abundantly in temperate lands but very meagerly in the tropics. Being perhaps confined to high mountains in the tropics, they may have escaped the notice of collectors, but these three Marquesan genera are unlike any other genera as yet known to Berland. It is tempting to suggest that they belong to Skottsberg's "Old Pacific" element, derived from Antarctica, and now represented in the mountains of Pacific islands. Berland (5a), however, finds no affinity between the spiders of the "Province Antarctique" and those of the central Pacific islands.

The development of the genus *Sandalodes* in Hawaii and the Marquesas alone among the Pacific islands is very striking, because it is the only feature shown by the spiders—with a possible exception in the genus *Ariadna*—that unites the Marquesas with Hawaii rather than with the islands to the southwest, and because similarly isolated affinities, contrasting with a more general relation in the other direction, are already known in some of the insects and mites, as well as in the flora.

In his papers on the Marquesas, Berland has not estimated the age of these islands as indicated by the spiders, but in discussing the fauna of Samoa (2), he states that the degree of endemism—which appears to be not very different from that of the Marquesan

spiders—can be explained only by long isolation, going back perhaps into the Miocene.

Recently Berland has written an excellent and comprehensive account of "Les Araignées du Pacifique" (5a). He finds it impossible to dispense with former land connections and writes:

> Tout semble bien indiquer que le peuplement du Pacifique s'est fait par des migrations provenant de la région indo-malaise . . . . un courant de migration bien distinct, mais de même origine, aurait peuplé la Polynésie, dont les archipels actuels ne constituent probablement que le morcellement d'un continent plus étendu, avec un rameau se détachant vers les Hawaï.

Endemism being high in almost all Pacific islands, Berland (5a) estimates the date of their isolation as not later than the middle of the Tertiary and perhaps much earlier.

The Marquesans appear to have only two names for spiders: *punaveevee* and *tufiti*. According to some informants, *punaveevee* is applied only to the large *Heteropoda regia* and *H. nobilis*; according to others, it is the general term for all kinds of spiders, the name *tufiti* being used only for the jumping spiders or Salticidae.

Acarina

Only parts of the collections of mites and ticks from the Marquesas have been reported upon by specialists, and a very incomplete review of them is all that can be attempted here. It is based largely on the work of Jacot (30) on the mites; the determinations used here are all his, except those of some ticks kindly made by Mr. Cecil Warburton, and of ecto-parasites of rats given in a paper by Ferris (20).[4]

Small free-living mites are common in many kinds of habitats at all altitudes throughout the Marquesas and form an important element in the endemic fauna. They were collected as they were found in the course of general field work, without methods designed especially for them. The collection would probably have been very greatly increased by the use of apparatus such as the Berlese funnel, but

[4] Recently a further report on Marquesan mites has been published by Vitzthum (52), with descriptions of the following species as new: *Nothrholaspis planus, Cypholaelaps semiglobulus, Anoplocelaeno marquesana, Cercomegistus simplicior, Dinychopsis pacifica, Uropoda bistellaris, Uropoda masculinata, Fuscuropoda hippocrepoides, Fuscuropoda furcigera, Caeculisoma cordipes, Histiostoma granulatum*, and recording the following species which have been found elsewhere: *Epicrosetus seurati* Berlese, *Fuscuropoda hippocrepea* (Berlese), *Cilliba bordagei* Oudemans, *Biscirus symmetricus* (Kramer), *Alloptes phaetontis* (Fabricius), *Eriophyes premnae* Nalepa. None of the above genera are peculiar to the Marquesas. The opinions expressed by Jacot regarding the affinities of the Marquesan mites do not require much modification as a result of Vitzthum's studies.

though it doubtless includes only a small part of the number of species occurring in the Marquesas it is probably representative enough to give some idea of the extent of diversity in the mite fauna.

Of parasitic mites, and ticks, only a few species were collected on their hosts. Some mites were taken on beetles, and on a few other insects. Three species were found on rats: the Marquesan "native" rats, which are of uncertain position among the members of the genus *Rattus* inhabiting the Pacific islands and which were probably brought to the Marquesas by the ancient Polynesian navigators, and the introduced brown rat, *Rattus norvegicus*. Three or four species of land birds were examined for ecto-parasites, but no acarines were found on them; there may be interesting species on some of the endemic birds which have not yet been searched. The cattle-tick *Boophilus australis* is now common in the Marquesas.

No fresh-water mites were found. Minute species, that cling to mosses and algae in the streams, may occur, but it is not unlikely that the meager fresh-water fauna includes none of the true water-mites or Hydracarina.

Endemism in the mites of the Marquesas is fairly high, so far as can be judged by the large proportion of species as yet unknown elsewhere. Among the 24 genera of mites mentioned here, however, all but one—the oribatid *Nesiotizetes*—have been found in other places. Island endemism within the Marquesas is shown chiefly by forms as yet collected each on a single island. These are carefully distinguished by Jacot, and in some species he separates forms inhabiting different parts of one island.

As for the origin and affinities of the Marquesan mites, Jacot (30, p. 237) writes: "The relations of the fauna are with New Zealand (*Acronothrus nukuhivae*), South America (*Paraschelobates*), but chiefly with the East Indies and Hawaii." So little is known about the mites of other Pacific islands that he advances no further conclusions. The Hawaiian affinities are interesting, being paralleled by some in other groups of animals. The American affinities are exceptional, there being scarcely any as yet found among the rest of the fauna.

PARASITIDAE

The gamasid mites are well represented in the Marquesas. One or two undescribed species are reported by Jacot (in litt.) in each of the following genera: *Cercomegistus, Cypholaelaps, Nothrholaspis, Uro-*

poda, Fuscuropoda (?), and *Dinychopsis.* Most of them were found under dead leaves and bark. Some of them appear to be confined to high altitudes, which suggests that they belong to the truly endemic fauna. *Anoplocelaeno ramifera* (Kramer), previously known only from southern Chile, was found at nearly 4,000 feet on Mt. Temetiu, Hivaoa. *Epicroseius seurati* Berlese and *Fuscuropoda hippocrepea* Berlese, both known also in the Society Islands, were taken at low levels near Atuona, Hivaoa. *Cilliba bordagei* Oudemans, found at low levels in the Marquesas, occurs also in Tahiti and in Reunion Island in the Indian Ocean. The Marquesan "native" rats were found to be infested by *Laelaps hawaiiensis* Ewing, found also on Hawaiian and Samoan rats, and *L. echidninus* Berlese, which occurs as far off as the East Indies.

IXODIDAE

The cattle tick *Boophilus australis* Fuller, which according to Brumpt (6) occurs in Central and South America, Australia, and the Indies, was collected on Hivaoa on domestic cattle and horses. These animals are sometimes heavily infested by the ticks, for which the Marquesans use the name *utu,* the common term for louse, combined with *pifa* from the French *boeuf.*

ARGANTIDAE

On a dead nestling of the sooty tern (*Sterna fuscata*), in a great nesting colony on Teuaua Islet, off Uahuka, I found a single nymph of *Ornithodorus jalaje* Guérin-Méneville, in September 1929. According to Brumpt (6) this tick is distributed from Mexico to Paraguay and has been reported once from the Gold Coast in Africa. It is known to infest several species of mammals, and more rarely of birds. It has been recorded from Peru on nestlings of *Sula nebouxi* on guano islands, a habitat similar to that of the specimen from Uahuka. Brumpt considers it likely that more than one species are included here; Mr. Warburton writes that the Marquesan specimen resembles the variety *capensis,* but he could make no further determination of a nymph.

ERYTHRAEIDAE

An undescribed species of "running mite" in the genus *Caeculisoma* was found at 2,000 feet at Hitikau on Uahuka.

BDELLIDAE

The "snout mite" *Biscirus symmetricus* (Kramer), previously known only from Tierra del Fuego, was collected at high altitudes on Hivaoa and Uapou.

ERIOPHYIDAE

Premna tahitiensis, one of the commonest shrubs at low and intermediate levels in the Marquesas, is very often heavily infested with leaf galls containing *Eriophyes premnae* Nalepa, originally described from galls on *Premna cyclophylla* in Java.

LISTROPHORIDAE

The minute *Listrophoroides expansus* Ferris (20) was described from rats from Hivaoa. One rat that I examined was very heavily infested by them. Ferris writes that this species differs in certain respects from *L. aethiopicus* Hirst, the genotype and only other known species, but he refrains from making a new genus for it.

ORIBATIDAE

The beetle-mites, like the gamasids, are well represented in the endemic Marquesan fauna. Jacot (30) describes a new genus with one species, *Nesiotizetes adamsoni,* collected at 2,000 feet on Nukuhiva; a new subgenus with one new species, *Scheloribates* (*Paraschelobates*) *mumfordi* from the mountains of Hivaoa and Uapou; and a third new species, *Acronothrus nukuhivae* from altitudes of 2,800 feet and above on Nukuhiva and Hivaoa. The remaining oribatids recorded by Jacot have all been found elsewhere, most of them in Hawaii only, and in the Marquesas they are represented by new subspecies, described by Jacot, as follows: *Udetaliodes hawaiiensis aculeatisetae, Scheloribates fimbriatus whitteni, Scheloribates indicus marquesalis, Zetes byrani marquesi, Galumna hawaiiensis marquesana.*

PHTHIRACARIDAE

Two species are described from the Marquesas by Jacot (30): *Phthiracarus insularis* from Nukuhiva, at about 2,000 feet, and *Indotritia lebronneci,* represented by two forms on Nukuhiva, and by a subspecies on Hivaoa and one on Tahiti in the Society Islands.

TYROGLYPHIDAE

Rhizoglyphus natiformius Jacot (30) was described from the Marquesas, where it was collected at about 4,000 feet on Hivaoa, and

Dr. Jacot reports that mites found on a nitidulid beetle at 2,500 feet on Hivaoa belong to an undescribed species of *Histiostoma.*

MOLLUSCA

The collections of land and fresh-water snails are being studied by Dr. C. Montague Cooke, Jr. What follows is based on conversations with Dr. Cooke, on his "Notes on Marquesan land shells" (14), and on my observations in the field. Both Dr. Cooke and Dr. H. A. Pilsbry have been kind enough to read and criticize the manuscript of these pages.

Andrew Garrett (23), who visited some of the Marquesas Islands about 1870, collected mostly at low and intermediate levels, and reported 52 species, a few of which were recorded by earlier writers and not found by Garrett. Between his time and the year 1929 scarcely any field work was done. Dr. H. A. Pilsbry of the Pinchot South Sea Expedition collected on five of the islands in September 1929.

A considerable amount of time was spent by the members of the Pacific Entomological Survey in collecting land snails, especially on Hivaoa and Nukuhiva, and less time on Tahuata and Fatuhiva among the six higher islands. Most attention was paid to arboreal species; relatively few collections were made under stones and none by sifting moss, dead leaves, and other debris for minute species. The other general methods of collecting covered the habitats of land snails, so far as I know them, in more or less equal degree. The fauna is sufficiently well known for the recognition of its general features, but Dr. Cooke believes that 25 to 50 percent of the total number of species have yet to be collected.

About 92 species of land and fresh-water snails have been collected in the Marquesas. Of these 72 (about 78 percent) are endemic. The occurrence of the rest is attributed by Dr. Cooke to dispersal by human agencies. The endemic species are divided between the Zonitidae (about 28), Endodontidae (about 12), Pupillidae (6), Partulidae (about 18), Tornatellinidae (about 11), Succinidae (2), and Helicinidae (about 8).

In the fresh-water fauna only 1 species of *Neritina,* 2 of *Melania,* and 1 of *Navicella* were found. No Pelecypoda are known, or to be expected.

The land snails are one of the most important elements of the

cloud-zone fauna, to which a large proportion of the species appears to be restricted. At intermediate levels, some endemic species, especially zonitids, are abundant. On the uninhabited islands, and below about 1,000 feet on the higher islands, the only endemic species seen were small snails, such as the Tornatellinidae, Pupillidae, Endodontidae, and Helicinidae. Garrett (23), however, found a number of species abundant at low and intermediate levels, which we did not collect, or found only in the cloud zone. This may be due to the fact that we did less field work at intermediate levels than higher up; it is also not unlikely that some lowland species of snails have disappeared since Garrett's time.

ZONITIDAE

In number of species the zonitids form the largest family of land snails in the Marquesas. Several species of *Microcystis* and *Trochonanina* are very abundant on all of the higher islands from 1,000 to 1,500 feet upwards. At intermediate levels, from 1,000 to 2,000 feet, they are thus perhaps the most conspicuous element in the endemic fauna, since most other genera of land snails and most of the arthropods reach their greatest development at higher levels.

Microcystis marquesana Pease, with peculiar characters possibly of subgeneric rank, is numerous and conspicuous on the vegetation in the small region of cloud zone on Uahuka.

On Uapou an undescribed species of *Microcystis,* perhaps constituting a seperate subgenus, was found in large numbers on foliage from about 2,000 feet upwards.

There are three remarkable species of *Trochonanina* on Nukuhiva: *T. rectangula* Pfeiffer; a large, flattened, dark-brown, new species; and a smaller, conic, brown one. They were found by us only on the mountains to the west and northwest, at altitudes of over 3,000 feet, *T. rectangula* in abundance on the foliage, the large new species only among dead vegetation on the ground, where it was not uncommon.

It is remarkable that each of these highly evolved zonitids should have no allied forms on other islands. Yet each of them is so abundant and conspicuous that if there were related species, of similar habit, elsewhere in the Marquesas, I think they would have been discovered. Several new species and races of the *T. subvenosa*

Ancey and *T. angulifera* Ancey groups were taken on Hivaoa, Tahuata, and Uahuka.

Species of *Helicarion* (or a superficially similar, endemic genus) appear to be strictly limited to the cloud zone, where they are the most abundant land snails to be seen, crawling actively on the foliage, above altitudes of about 2,500 feet. The distribution of this genus in the Marquesas is remarkable. A single species inhabits Hivaoa, Tahuata, and Fatuhiva in the southeast group and Uapou in the central islands. On Uahuka it is replaced by a larger species, and on Nukuhiva none was found. *Helicarion* is so conspicuous on the islands where it occurs that it must certainly be absent from Nukuhiva, unless replaced by forms of quite different habit.

ENDODONTIDAE

This is one of the most interesting families in the Marquesas. Some of the 12 species of *Thaumatodon,* the only genus represented, have highly specialized characters. One species was found in large numbers under bark on Eiao and Hatutu. The others were found in very small numbers, mostly on the ground among dead leaves, in the cloud zone. Though a considerable amount of time was spent in searching this habitat, it is likely that very many species of endodonts are yet to be found in the Marquesas. It is possible that many species, with similar habits to that of Eiao and Hatutu, have been overlooked at low and intermediate levels on the higher islands.

STENOGYRIDAE

Some widely distributed species—*Subulina octona* and two or three species of *Opeas*—are abundant throughout the six inhabited islands. One or more of them were commonly found even in the cloud zone above 3,000 feet.

PUPILLIDAE

The endemic *Pronesopupa simplaria* Pease, belonging to a genus of which few species are known outside Hawaii, was found on Hivaoa, Fatuhiva, Nukuhiva, and Uahuka. The two species of *Gastrocopta* and three of *Nesopupa* appear to have been dispersed by human agencies.

PARTULIDAE

More attention was paid to collecting *Partulae* than any other land snails. They are almost always to be seen in fairly large

numbers on foliage in the cloud zone; their apparent absence at low levels was surprising, especially after one had found *Partulae* in great numbers almost down to sea level in the Tahitian valleys. In the Marquesas we never found them in abundance much below 2,000 feet, though a single specimen was taken at only 50 feet in Taipivai. No *Partulae* were found in Tovii in central Nukuhiva, in forest that seemed favorable for their development, until an altitude of about 3,000 feet was reached at Tapuaooa. Two species were numerous on the scattered trees there in November 1929; but on a second visit to Tapuaooa, during very wet weather, LeBronnec and Tauraa were unable to find any on the trees. The habits of the Marquesan *Partulae* must therefore be taken into account in considering their distribution on the basis of these collections. Though some time was spent in collecting among dead leaves, only empty shells were ever found on the ground. Strictly terrestrial species may, however, have escaped notice; moreover, as Crampton (15) has shown, many species of *Partula* spend only part of their time on the trees.

It is not impossible that *Partula* may once have inhabited Eiao, though present conditions seem to be entirely unfavorable. I made a brief search for fossil shells, without success.

The Marquesan *Partulae* belong to a subgenus, *Marquesana* Pilsbry, endemic to these islands.

TORNATELLINIDAE

The small snails of this family are represented at all altitudes and in all types of country. Dr. Cooke finds that most of the species are of wide distribution or likely to be found, on further collecting, in other island groups. Three endemic species of *Lamellidea* are described by Pilsbry and Cooke (39) in a new subgenus, *Atea,* created for them. The most interesting tornatellinid, a species of this subgenus, was conspicuous in the cloud zone on Uapou.

SUCCINIDAE

Having seen the members of this family in great abundance on trees and shrubs in Hawaii and the Society Islands, I was surprised to see none at all in the Marquesas. A fair amount of collecting among dead leaves on the ground proved fruitless until, on our first visit to the northwestern mountains of Nukuhiva, LeBronnec found

a single live snail and one empty shell on Oumu, at 3,700 feet. Garrett, prior to 1871, found *Succinea mamillata* Pease common on the ground in mountain ravines of Nukuhiva, and *S. marquesana* Garrett common under dead leaves on Hivaoa.

VAGINULIDAE

No native slugs are known on the oceanic islands of the Pacific. A widely distributed species of *Veronicella* was found at low levels on Hivaoa. Père Siméon Delmas, of Taiohae, told me that he had never seen it on Nukuhiva, and Marquesans asserted that it was absent from Fatuhiva. The Marquesans have named it *mamafenua* (*mama,* chiton; *fenua,* land). The only other slug in our collection was a single specimen of an undetermined species, which was found, oddly enough, at the very summit of Mount Ootua, Hivaoa, at an altitude of 3,030 feet.

REALIIDAE

Records of two species of *Omphalotropis* by Pfeiffer (36) are regarded by Dr. Cooke as questionable.

ASSIMINEIDAE

The widely distributed *Assiminea nitida* Pease was found only on Eiao, and reported by Garrett, without locality, from the Marquesas.

HELICINIDAE

Interesting endemic species of this family are common in the cloud zone. They were most often found in the leaf axils of *Freycinetia.* A new species of *Aphanoconia* was found in abundance in company with *Thaumatodon* on Eiao; the shells were sealed, under bark, and the snails were apparently "aestivating" through the drought prevailing in October 1929.

HYDROCENIDAE

Two widely dispersed Polynesian species of *Georissa* were recorded by Garrett. Neither of these was collected by us.

NERITIDAE AND MELANIIDAE

The fresh-water molluscan fauna of the Marquesas is as limited as might be expected. Only 4 species were found, *Neritina* (*Clithon*) *souleyetiana, Navicella apiata* Guillou, and 2 species of *Melania.*

Neritina is abundant in the streams at low levels and *Melania* up to high altitudes. *Navicella* was found only once, at Vaituha, Eiao. By a curious coincidence this species and the isopod *Ligia vitiensis* were found, in company, at this locality only. Both are doubtless more generally distributed in the Marquesas.

The nerites have been fairly recently derived from marine forms, as have some other members of the fresh-water fauna such as the Palaemonidae, but it is believed that these snails as well as *Melania* did not attain their present wide distribution in the Pacific until after they had acquired a fresh-water habit. Their origin on the Pacific islands would appear, therefore, to present much the same problem as that of the terrestrial genera.

The general Marquesan name for snails is *pipi. Neritina* is *pipita'a* (*ta'a,* a spine) and *Melania* is *pipihoaka.* With the exception of the introduced *Veronicella* (*mamafenua*), we obtained no "specific" Marquesan names for any land molluscs. But Dordillon (16) gives the name *pipiputaianu'u,* with variants, for "hélice pyramide", which may be *Trochonanina rectangula,* and *pipivao* for "coquillage des montagnes (esp. de)", and it is likely that the Marquesans once distinguished many species by name.

Most of the following general remarks are based on Cooke's "Notes on Marquesan land shells" (14, p. 15).

The affinities of the Marquesas, as regards their land-snail fauna, are with the islands to the southwest, the Marquesas having much in common with the Cook and Society Islands and in a smaller measure with the Austral Islands. There is no direct affinity with Hawaii.

The degree of endemism among the indigenous species of land snails in many central Pacific archipelagoes is nearly—if not actually —100 percent, since the non-endemic species are supposed to be recent immigrants! Of endemic genera, Hawaii has more than 20, Rapa 2 or 3, and the Society, Austral, and Cook Islands and Samoa none (13, p. 10). In the Marquesas there are a few endemic subgenera. It appears, however, that relatively few species have been evolved in the Marquesas, in comparison with the Society Islands, for example; more than 60 species were enumerated by Garrett (22) on the small island of Raiatea and more than 40 on Huahine, whereas only about 92 species are known from all of the ten Marquesas

Islands. This is surprising in view of the widely divergent characters that have been evolved in the Marquesan species of *Trochonanina, Microcystis, Thaumatodon,* and *Lamellidea.*

The amount of species formation among the genera with endemic species is apparently so uniform that these genera probably reached the Marquesas at about the same time. Since then no further migration appears to have occurred, until the arrival of species distributed by man.

There is a high degree of island endemism in the Marquesas.

With allowances for differences in the amount of collecting, and in the size and topography of the islands, it appears that the division of the species among the several islands in the Marquesas is fairly uniform, which suggests that the islands are all—except Mohotani—of similar ages. There is, however, a marked specialization in the central islands, in *Trochonanina* and *Thaumatodon* on Nukuhiva and in *Microcystis* on Uahuka and Uapou. But Hivaoa has about 25 known species peculiar to it, against about 22 on Nukuhiva, and Hivaoa and Tahuata have the most divergent species of *Partula.* Moreover, the faunas of Tahuata and Fatuhiva are little known in comparison with those of Uahuka and Uapou. The greater age indicated for the central islands may therefore be only apparent. It is interesting to note that Eiao and Hatutu have a few peculiar species, while none was found restricted to Mohotani. This is in accord with what is known regarding the insects of these three islands.

As Buxton (7) has said, the distribution of the land snails affords the most convincing evidence yet advanced in favor of past land connections in the Pacific. (See 37, 38, 13, 15.) This evidence—such as the homogeneity of the fauna throughout a wide area in the central Pacific and the natural occurrence of only a few, ancient families—is too well known to be discussed here. But it should be noted that even the malacologists have disagreed; Hedley (25) believed that islands east of Fiji, the eastern limit of *Placostylus,* are truly oceanic.

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CHECK LIST OF THE SERPHOIDEA, BETHYLIDAE, AND ANTEONIDAE OF OCEANIA

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BERNICE P. BISHOP MUSEUM

OCCASIONAL PAPERS

VOLUME XI, NUMBER 18

HONOLULU, HAWAII

PUBLISHED BY THE MUSEUM

1936

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By Robert Fouts

The Oceanic islands considered in this paper are those lying to the east of the Philippines and to the north and east of New Guinea and Australia, omitting Lord Howe and Norfolk Islands, New Zealand with adjacent islands, and the subantarctic islands. The main groups of islands included in the territory considered are the Galapagos, the Marquesas, Society, Samoa, Tonga, Fiji, New Hebrides, New Caledonia, Solomon, Marshall, Caroline, Marianas and Hawaiian islands (Hawaii, Maui, Molokai, Oahu, Kauai, Lanai, Nihoa, Kaula). The following genera have been recorded from the Pacific Oceanic islands only: *Zacranium, Platymischoides, Dyscritobaeus, Caenoteleia, Nesepyris,* and *Sierola* (one doubtful species in the United States). *Pseudobaeus, Aphanomerus,* and *Echthrodelphax* occur, as far as known, only in Australia and the Hawaiian islands. *Anteromorpha dubiosa,* described from Oahu, has been recorded from the Society and Marquesas islands. It may also occur in Australia as it seems probable that *A. australica* Dodd is a synonym.

Representative of *Microphanurus,* a genus of world-wide distribution, have been found in Australia, Tasmania, Fiji, and the Hawaiian islands. *Sclerodermus,* with similar world-wide distribution, occurs in the Hawaiian, Marianas, and Galapagos islands. *Paragonatopus,* with one species, *P. nigricans,* has been recorded from Australia and Fiji.

Family SERPHIDAE

Serphus (?) hawaiiensis Ashmead: 3,* p. 294 (*Proctotrypes*).—Kieffer: 28, p. 16 (*Serphus*). Hawaii, Maui.

Exallonyx philonthiphagus Williams: 65, p. 205. Hawaii, reared from *Philonthus turbidus.*

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* Numbers refer to the Bibliography, pp. 13-15.

Family CALLICERATIDAE

Calliceras plebeia (Perkins): 39, p. 616 (*Ceraphron*).—Kieffer: 28, p. 114 (*Calliceras*). Oahu.

Calliceras obscura Fouts: 18. Marquesas Islands: Eiao, on *Hibiscus tiliaceus.*

Calliceras robusta Fouts: 18. Marquesas Islands: Eiao, Uahuka, on *Premna tahitensis.*

Allomicrops abnormis (Perkins): 39, p. 616 (*Ceraphron*).—Kieffer: 28, p. 138 (*Allomicrops*).—Swezey: 46, p. 22. Parasite of *Haplogonatopus* and *Echthrodelphax,* introduced from California. Oahu.

Family DIAPRIIDAE

Galesus silvestrii Kieffer: 27, p. 91; 30, p. 225. Parasite in puparia of *Ceratitis capitata, C. colae, Dacus oleae,* and *D. bipartitus.* Oahu, Hawaii, Kauai, Maui. Also Italy and north and west Africa.

Zacranium oahuense Ashmead: 3, p. 295. Oahu.

Platymischoides molokaiensis Ashmead: 3, p. 296. Molokai.

Phaenopria ambulator Perkins: 39, p. 627. Oahu.

Phaenopria hylaea Perkins: 39, p. 628. Oahu.

Phaenopria perkinsi Kieffer: 30, p. 64 (= *P. montana* Perkins: 39, p. 628). Oahu.

Phaenopria hawaiiensis Ashmead: 3, p. 296. Molokai.

Phaenopria subtilis Perkins: 39, p. 627. Oahu.

Phaenopria frater Perkins: 39, p. 626. Oahu.

Phaenopria soror Perkins: 39, p. 627. Hawaii. Deposits eggs in larvae of *Drosophila.*

Phaenopria insulana Fouts: 18. Society Islands: Tahiti, on sugarcane.

Phaenopria lebronnecii Fouts: 18. Marquesas Islands: Hivaoa, on *Glochidion ramiflorum.*

Trichopria (Planopria) drosophilae (Perkins): 39, p. 629 (*Diapria*).—Kieffer: 30, p. 118 (*Trichopria*). Oahu.

Family SCELIONIDAE

Subfamily Telenominae

Telenomus mataiaensis Fouts: 18. Society Islands: Tahiti. Marquesas Islands: Eiao, Hivaoa. On sugar cane, *Crossostylus biflora,* and *Melochia velutina.*

Telenomus mumfordi Fouts: 18. Marquesas Islands: Hivaoa.

Phanurus beneficiens (Zehntner): 66, p. 487 (*Ceraphron*).—Rust: 43, p. 223. —Swezey: 54, p. 283. In Java a parasite of the eggs of *Grapholitha schistaceana,* a moth borer of the sugar cane. Introduced into Fiji.

Phanurus nawai (Ashmead): 4, p. 72 (*Telenomus*).—Rosa: 42, pp. 370, 374. —Swezey: 57, vol. 6, pp. 378, 503, 558; vol. 7, pp. 3, 206, 236, 272, 284, 484.—Kieffer: 31, p. 57 (*Phanurus*). Parasite in eggs of *Spodoptera mauritia.* Oahu, Kauai, Molokai, and Japan.

Microphanurus vulcanus (Perkins): 39, p. 619 (*Telenomus*).—Kieffer: 31, p. 110 (*Microphanurus*). Hawaii.

Microphanurus adelphus (Perkins): 39, p. 619 (*Telenomus*).—Kieffer: 31, p. 110 (*Microphanurus*). Oahu.

Microphanurus girault (Dodd): 15, p. 161 (*Telenomus*).—Kieffer: 31, p. 113 (*Microphanurus*). Fiji: Suva.

Microphanurus despiciendus (Perkins): 39, p. 618 (*Telenomus*).—Kieffer: 31, p. 111 (*Microphanurus*). Oahu.

Microphanurus paractias (Perkins): 39, p. 619 (*Telenomus*).—Kieffer: 31, p. 114 (*Microphanurus*). Oahu, parasite in eggs of *Rhopalus hyalinus*.

Microphanurus rhopali (Perkins): 39, p. 618 (*Telenomus*).—Kieffer: 31, p. 111 (*Microphanurus*). Oahu, parasite in eggs of *Rhopalus hyalinus*.

Subfamily Baeinae

Baeus persodidus Perkins: 39, p. 622. Oahu.

Pseudobaeus peregrinus Perkins: 39, p. 621. Oahu.

Dyscritobaeus comitans Perkins: 39, p. 622. Oahu.

Aphanomerus pusillus Perkins: 37, p. 203.—Swezey: 51, p. 303; 54, p. 285; 56, p. 497.—Swezey and Bryan: 58, p. 295. Australia, Hawaiian islands. Parasite in eggs of *Siphanta acuta*.

Subfamily Scelioninae

Scelio pembertoni Timberlake: 61, p. 155.—Swezey: 57, vol. 8, p. 228.—Pemberton: 33, p. 243; 34, p. 253. Indo-Malayan region: Introduced into Oahu. Parasite of *Oxya chinensis* (Thunberg).

Scelio setiger Brues: 11, p. 121. Solomon Islands: Ugi.

Cacellus caeruleus Brues: 11, p. 122. Solomon Islands: Santa Cruz.

Anteromorpha dubiosa (Perkins): 39, p. 623 (*Opisthacantha*).—Dodd: 16, p. 38 (*Anteromorpha*).—Fouts: 18. Oahu. Society Islands: Tahiti. Marquesas Islands: Mohotani.

Prosanteris hawaiiensis (Ashmead): 3, p. 298 (*Anteris*).—Kieffer: 26, p. 136 (*Prosanteris*). Lanai.

Prosanteris montana (Perkins): 39, p. 623 (*Anteris*).—Kieffer: 31, p. 439 (*Prosanteris*). Oahu.

Prosanteris nigricornis (Ashmead): 3, p. 298 (*Anteris*).—Kieffer: 26, p. 136 (*Prosanteris*). Lanai.

Prosanteris oahuensis (Perkins): 39, p. 624 (*Anteris*).—Kieffer: 31, p. 439 (*Prosanteris*). Oahu.

Prosanteris perkinsi (Ashmead): 3, p. 298 (*Anteris*).—Kieffer: 26, p. 136 (*Prosanteris*). Kauai.

Prosanteris tarsalis (Ashmead): 3, p. 298 (*Anteris*).—Kieffer: 26, p. 136 (*Prosanteris*). Kauai.

Hadronotus suvaensis Dodd: 15, p. 161. Fiji: Suva.

Ceratoteleia exul (Perkins): 39, p. 625 (*Caloteleia*).—Kieffer: 31, p. 507 (*Ceratoteleia*). Oahu.

Caenoteleia elegans (Perkins): 39, p. 624 (*Caloteleia*).—Kieffer: 31, p. 550 (*Caenoteleia*). Oahu.

Macroteleia manilensis Ashmead: 5, p. 963.—Fullaway: 19, p. 283. Philippine Islands: Manila. Marianas Islands: Guam.

Platyscelio wilcoxi Fullaway: 19, p. 283. Marianas Islands: Guam.

Family PLATYGASTERIDAE

Allotropa thompsoni Fullaway: 19, p. 284. Marianas Islands: Guam.

Brachinostemma abnorme (Perkins): 39, p. 626 (*Inostemma* ?).—Kieffer: 31, p. 595 (*Brachinostemma*). Oahu.

Synopeas levis Fouts: 17, p. 327. Marquesas Islands: Hivaoa, Eiao.

Prosactogaster insularis Fouts: 17, p. 329. Marquesas Islands: Hivaoa.

Prosactogaster venustus Fouts: 17, p. 329. Marquesas Islands: Eiao, on *Dodonaea viscosa.*

Platygaster mumfordi Fouts: 17, p. 330. Marquesas Islands: Hivaoa, on *Crossostylus biflora.*

Platygaster compressus Fouts: 17, p. 331. Marquesas Islands: Hivaoa, on *Crossostylus biflora.*

Family ANTEONIDAE

Echthrodelphax fairchildii Perkins: 35, p. 37.—Perkins: 36, p. 49.—Perkins: 40, pl. 3, fig. 5. Reared from nymphs of *Perkinsiella saccharicida* and *Aloha ipomeae.* Hawaiian islands. First known only from Kauai and Oahu; introduced later for economic reasons into the other islands.

Pseudogonatopus kiefferi Perkins: 37, p. 487. Possibly parasitic on *Vanua vitiensis.* Fiji: Suva.

Pseudogonatopus perkinsi (Ashmead): 3, p. 293 (Gonatopus).—Perkins: 37, p. 487 (*Pseudogonatopus*). Reared from various delphacids related to *Liburnia.* Hawaii, Molokai, Maui.

Pseudogonatopus rufus Fouts: 18. Marquesas Islands: Nukuhiva.

Pseudogonatopus rugosus Fouts: 18. Marquesas Islands: Nukuhiva.

Laberius hawaiiensis (Ashmead): 3, p. 294 (*Labeo*).—Perkins: 37, p. 487.—Kieffer: 29, p. 66 (*Laberius*). Molokai.

Paragonatopus nigricans Perkins: 36, p. 41.—Perkins: 37, p. 487 (*Pseudogonatopus melanacrias* Perkins). Parasitic on *Liburnia* species. Australia, Fiji.

Haplogonatopus vitiensis Perkins: 37, p. 488. Reared from a delphacid closely related to *Stenocranus* on *Zoysia pungens.* Fiji: Suva.

Gonatopus anomalus Perkins: 40, p. 14. Reared from jassids. Fiji.

Gonatopus haleakalae Ashmead: 3, p. 293. Maui, Haleakala.

Gonatopus vitiensis (Perkins): 37, p. 490 (*Neogonatopus*).—Perkins: 40, p. 13. (*Gonatopus*). Reared from *Euleimonios* species and *Deltocephalus* species. Fiji: Suva.

Anteon dubius Fouts: 18. Marquesas Islands: Nukuhiva.

Agonatopus heterothorax Perkins: 38, p. 32. Parasite of Jassid nymphs on grass. Oahu: Honolulu.

Family BETHYLIDAE

Cephalonomia gallicola (Ashmead): 1, p. 75.—Ashmead: 2, p. 48.—Bridwell: 8, p. 33. Maui, imported in rolled barley from California.

Cephalonomia hyalinipennis Ashmead: 2, p. 49.—Bridwell: 8, p. 33. Maui, imported in rolled barley from California.

Cephalonomia peregrina Westwood: 62, p. 127.—Swezey, 57, vol. 8, pp. 226, 238. Ceylon. Oahu. Bred from *Catorama mexicana.*

Cephalonomia unicolor Fouts: 18. Marquesas Islands: Hivaoa.

Sclerodermus breviventris (Ashmead): 3, p. 286 (*Scleroderma*). Lanai.

Sclerodermus chilonellae Bridwell: 8, p. 31.—Swezey: 57, vol. 4, p. 287.—Timberlake: 59, p. 175. Reared from *Hyposmocoma chilonella* in *Pipturus.* Oahu.

Sclerodermus chlorodes (Perkins): 39, p. 613 (*Scleroderma*). Oahu.

Sclerodermus duarteanum Fullaway: 19, p. 283. Collected in cacao. Marianas Islands: Guam.

Sclerodermus euprepes (Perkins): 39, p. 612. (*Scleroderma*). Kauai.

Sclerodermus galapagensis Brues: 12, p. 309.—Williams: 64, p. 356. Galapagos Islands.

Sclerodermus immigrans Bridwell: 7, p. 484.—Bridwell: 8, p. 25.—Bridwell: p. 119.—Bridwell: 9, pp. 291, 293. Oahu.

Sclerodermus kaalae (Ashmead): 3, p. 285 (*Scleroderma*).—Bridwell: 8, p. 27.—Swezey: 57, vol. 2, p. 113. Oahu.

Sclerodermus lanaiensis (Ashmead): 3, p. 285 (*Scleroderma*).—Kieffer: 29, p. 267 (*Sclerodermus*). Lanai.

Sclerodermus manoa Bridwell: 8, p. 28-30.—Timberlake: 59, p. 176. Oahu, parasitic on Lepidopterus larva, probably *Semnoprepia* species.

Sclerodermus muiri Bridwell: 8, p. 32.—Bridwell: 9, p. 303.—Timberlake: 59, p. 175. Hawaii, in wood of *Straussia.*

Sclerodermus nigriventris (Ashmead): 3, p. 285 (*Scleroderma*).—Kieffer: 29, p. 267 (*Sclerodermus*). Lanai.

Sclerodermus nihoaensis Timberlake: 60, p. 21. Nihoa, on *Euphorbia.*

Sclerodermus perkinsi (Ashmead): 3, p. 284 (*Scleroderma*).—Kieffer: 29, p. 268 (*Sclerodermus*).—Swezey: 47, p. 101.—Bridwell: 8, p. 27. Hawaii, Oahu, Kauai, Lanai.

Sclerodermus poecilodes (Perkins): 39, p. 613 (*Scleroderma*).—Bridwell: 8, p. 27. Associated with larvae of *Semnoprepia* ? in dead stems of *Smilax.* Oahu.

Sclerodermus polynesialis (Saunders): 44, p. 116 (*Scleroderma*).—Bridwell: 8, p. 27.—Ashmead: 3, p. 284. Oahu, Maui.

Sclerodermus semnoprepiae Bridwell: 8, p. 30.—Swezey: 48, p. 382. Bred from larvae of *Semnoprepia* species in *Coprosma longifolia.*

Sclerodermus sophorae (Perkins): 39, p. 614 (*Scleroderma*).—Kieffer: 29, p. 268. (*Sclerodermus*). From dry wood of *Sophora.* Hawaii.

Sclerodermus tantalus Bridwell: 8, p. 32; 9, pp. 304, 331.—Timberlake: 59, p. 176. Oahu.

Epyris armatitarsis Kieffer: 24, p. 399. Kieffer: 29, p. 402 (*Acanthepyris*). Tunis.—Bridwell: 6, p. 279. Hawaiian islands.

Epyris extraneus Bridwell: 6, p. 278.—Williams: 63, pp. 55-63.—Bridwell: 9, p. 304.—Williams: 63, p. 55.—Illingworth, 23, p. 397.—Swezey: 49, p. 488; 50, p. 521. Oahu, Maui, Kauai, Molokai. Preys on larvae of *Gonocephalum seriatum* (Boisduval).

Holepyris hawaiiensis (Ashmead): 3, p. 286 (*Eypris*).—Kieffer: 25, p. 111.—Bridwell: 9, pp. 311-314.—Bridwell: 6, p. 276.—Pemberton: 32, p. 125. Oahu, Kaula.

Holepyris hospes Perkins: 39, p. 615. Oahu.

Nesepyris ewa Bridwell: 9, p. 310. Oahu.

Apenesia malaitensis Brues: 11, p. 124. Solomon Islands: Malaita, Auki.

Perisierola cellularis (Say): 45, p. 279 (*Bethylus*).—Fullaway: 19, p. 283 (*Parasierola*).—Kieffer: 29, p. 536 (*Perisierola*). California, Nevada, Nicaragua. Marianas Islands: Guam.

Perisierola emigrata Rohwer: 41, pp. 1-3.—Bridwell: 8, pp. 21-23. Parasite of pink boll worm. Hawaiian islands.

Bethylopsis fullawayi Fouts: 18. Marquesas Islands: Nukuhiva.

Sierola abusa Fullaway: 21, p. 136. Oahu.

Sierola acuta Fullaway: 21, p. 74. Oahu, on sugar cane.

Sierola adamsoni Fullaway: 22, p. 358. Marquesas Islands: Nukuhiva, Hivaoa, on *Glochidion ramiflorum* and *Weinmannia parviflora*.

Sierola adumbrata Fullaway: 21, p. 141. Oahu.

Sierola affinis Fullaway: 21, p. 121. Oahu.

Sierola agens Fullaway: 21, p. 108. Oahu.

Sierola amica Fullaway: 21, p. 137. Oahu.

Sierola anemophila Fullaway: 21, p. 129. Oahu.

Sierola angustata Fullaway: 21, p. 84. Hawaii.

Sierola anthracina Fullaway: 21, p. 83. Oahu.

Sierola arida Fullaway: 21, p. 102. Oahu.

Sierola aristotelíae Fullaway: 21, p. 82. Reared from larvae of *Aristotelia* species infesting a *Gouldia* fruit. Oahu.

Sierola aspera Fullaway: 21, p. 153. Oahu.

Sierola atra Fullaway: 21, p. 154. Hawaii.

Sierola aucta Fullaway: 21, p. 144. Hawaii.

Sierola armata Fullaway: 21, p. 72. Oahu.

Sierola batrachedrae Fullaway: 21, p. 125. Oahu, reared from *Batrachedra* species infesting fern.

Sierola bella Fullaway: 21, p. 78. Oahu.

Sierola bicolor Fullaway: 21, p. 81. Oahu.

Sierola blackburni Fullaway: 21, p. 150. Hawaii.

Sierola brevicauda Fullaway: 21, p. 111. Oahu.

Sierola breviceps Fullaway: 21, p. 144. Oahu.

Sierola brevicornis Fullaway: 21, p. 85. Oahu.

Sierola bridwelli Fullaway: 21, p. 145. Oahu.

Sierola brunnea Fullaway: 21, p. 103. Oahu.

Sierola brunneipennis Fullaway: 21, p. 129. Oahu.

Sierola brunneipes Fullaway: 21, p. 102. Oahu, on *Acacia koa*.

Sierola brunneiventris Fullaway: 21, p. 149. Oahu.

Sierola bryani Fullaway: 22, p. 363. Marquesas Islands: Uapou, on *Cyathea* species.

Sierola callida Fullaway: 21, p. 100. Oahu, on *Bobea elatior.*

Sierola capuana Fullaway: 21, p. 113. Reared from larva of *Capua cassia* and *Archips longiplicatus.* Oahu.

Sierola carinata Fullaway: 21, p. 88. Hawaii.

Sierola celeris Fullaway: 21, p. 150. Oahu.

Sierola collaris Ashmead: 3, p. 292. Kauai.

Sierola compacta Fullaway: 21, p. 90. Hawaii.

Sierola conspicua Fullaway: 21, p. 141. Kauai.

Sierola cookei Fullaway: 22, p. 362. Marquesas Islands: Uapou, Hivaoa, on *Metrosideros* species.

Sierola crocelpes Fullaway: 21, p. 127. Hawaii.

Sierola cryptophlebiae Fullaway: 21, p. 119. Reared from larva of *Cryptophlebia illepida.* Oahu.

Sierola curiosa Fullaway: 21, p. 156. Oahu.

Sierola curvignatha Fullaway: 21, p. 79. Hawaii.

Sierola depressa Fullaway: 21, p. 145. Oahu.

Sierola depressa marquisensis Fullaway: 22, p. 357. Marquesas Islands: Hivaoa, on *Paspalum conjugatum.*

Sierola depressela Fullaway: 21, p. 95. Oahu.

Sierola dichroma Perkins: 39, p. 614. Oahu.

Sierola distincta Fullaway: 21, p. 72. On *Campylotheca, Straussia kaduana.* and *Pelea clusiaefolia.* Oahu, Hawaii.

Sierola distinguenda Fullaway: 21, p. 155. Oahu.

Sierola ehrhorni Fullaway: 21, p. 117. Hawaii.

Sierola emarginata Fullaway: 21, p. 79. Hawaii.

Sierola epagogeana Fullaway: 21 p. 135. Reared from larva of *Epagoge infaustana.* Oahu.

Sierola eucrena Fullaway: 21, p. 117. Hawaii.

Sierola flavicornis Fullaway: 21, p. 96. Oahu.

Sierola flavipennis Fullaway: 21, p. 99. Oahu.

Sierola flavipes Fullaway: 21, p. 137. Oahu.

Sierola flavocollaris Ashmead: 3, pp. 288, 291. (= *S. flavocollis* Ashmead, 3, p. 288). Maui, Kauai.

Sierola fossulata Fullaway: 21, p. 126. Oahu.

Sierola freycinetiae Fullaway: 22, p. 360. With variety *mataumaiana.* On *Freycinetia* and *Paspalum conjugatum.* Marquesas Islands: Hivaoa, Nukuhiva.

Sierola fuliginosa Fullaway: 21, p. 132. Oahu.

Sierola fusca Fullaway: 21, p. 127. Oahu.

Sierola fuscipennis Fullaway: 21, p. 91. Hawaii.

Sierola fuscipes Fullaway: 21, p. 99. Hawaii.

Sierola giffardi Fullaway: 21, p. 79. Oahu.

Sierola glabra Fullaway: 21, p. 95. Oahu.

Sierola gracilariae Fullaway: 21, p. 118. Reared from *Gracilaria mabaella.* Oahu.

Sierola gracillima Fullaway: 21, p. 102. Oahu.

Sierola gracilis Fullaway: 21, p. 78. Oahu.

Sierola gregoryi Fullaway: 22, p. 363. On *Cheirodendron* species. Marquesas Islands: Hivaoa.
Sierola hillebrandi Fullaway: 21, p. 121. Oahu.
Sierola hirsuta Fullaway: 21, p. 106. Hawaii.
Sierola hirticeps Fullaway: 21, p. 147. Oahu.
Sierola hivaoaensis Fullaway: 22, p. 359. On *Crossostylus biflora*. Marquesas Islands: Hivaoa.
Sierola holomelaena Fullaway: 21, p. 147. Hawaii.
Sierola humilis Fullaway: 21, p. 152. Maui.
Sierola illingsworthi Fullaway: 21, p. 142. Hawaii.
Sierola imparata Fullaway: 21, p. 139. Hawaii.
Sierola incita Fullaway: 21, p. 119. Oahu.
Sierola indecora Fullaway: 21, p. 134. Hawaii.
Sierola kaala Fullaway: 21, p. 86. Oahu.
Sierola kaalensis Fullaway: 21, p. 139. Oahu.
Sierola kaduana Fullaway: 21, p. 118. Oahu, on *Kadua acuminata*.
Sierola kalihiensis Fullaway: 21, p. 143. Oahu, on *Suttonia lassertiana*.
Sierola kauaiensis Ashmead: 3, p. 292. Kauai.
Sierola kauensis Fullaway: 21, p. 75. Hawaii.
Sierola kaumuohona Fullaway: 21, p. 149. Oahu.
Sierola kilauea Fullaway: 21, p. 111. Hawaii.
Sierola koa Fullaway: 21, p. 88. Oahu.
Sierola koebelei Fullaway: 21, p. 109. Oahu.
Sierola konana Fullaway: 21, p. 83. Hawaii.
Sierola koolauensis Fullaway: 21, p. 109. Oahu.
Sierola lacessita Fullaway: 21, p. 140. Oahu.
Sierola langfordi Fullaway: 21, p. 153. Oahu.
Sierola lanihuiana Fullaway: 21, p. 120. Oahu.
Sierola lata Fullaway: 21, p. 132. Oahu.
Sierola laticeps Fullaway: 21, p. 92. Hawaii.
Sierola lebronnecii Fullaway: 22, p. 361. On *Crossostylus biflora* and *Rapanea* species. Marquesas Islands: Hivaoa.
Sierola lepida Fullaway: 21, p. 100. Hawaii.
Sierola leuconeura Cameron: 14, p. 177.—Ashmead: 3, p. 289. Hawaii, Kauai, Lanai, Maui, Molokai, Oahu.
Sierola levigata Fullaway: 21, p. 94. Hawaii.
Sierola levis Fullaway: 21, p. 84. Oahu.
Sierola localis Fullaway: 21, p. 93. Oahu.
Sierola longicaudata Fullaway: 21, p. 92. Maui.
Sierola longiceps Fullaway: 21, p. 110. Hawaii.
Sierola longicornis Fullaway: 21, p. 101. Hawaii.
Sierola lugens Fullaway: 21, p. 116. Oahu.
Sierola luteipes Fullaway: 21, p. 123. Oahu.
Sierola magna Fullaway: 21, p. 75. Oahu.
Sierola mandibularis Fullaway: 21, p. 105. Oahu.
Sierola mandibulata Fullaway: 21, p. 130. Oahu.
Sierola manoa Fullaway: 21, p. 131. Oahu.
Sierola maulensis Fullaway: 21, p. 115. Maui.

Sierola megalognatha Fullaway: 21, p. 89. Hawaii.
Sierola megalops Fullaway: 21, p. 114. Oahu.
Sierola minuscula Fullaway: 21, p. 128. Oahu.
Sierola minuta Fullaway: 21, p. 106. Hawaii.
Sierola molokaiensis Ashmead: 3, p. 290.—Swezey: 47, p. 101. Hawaii, Lanai, Maui, Molokai, Oahu.
Sierola montana Fullaway: 21, p. 85. Oahu.
Sierola monticola Cameron: 14, p. 176.—Ashmead: 3, p. 289. Hawaii, Lanai, Maui, Molokai.
Sierola muiri Fullaway: 21, p. 80. Hawaii.
Sierola mumfordi Fullaway: 22, p. 357. Marquesas Islands: Nukuhiva, Hivaoa, on *Metrosideros collina*.
Sierola nemorensis Fullaway: 21, p. 142. Hawaii.
Sierola newelli Fullaway: 21, p. 154. Hawaii.
Sierola nigra Fullaway: 21, p. 131. Oahu.
Sierola nigrescens Fullaway: 21, p. 73. Hawaii.
Sierola nigrans Fullaway: 21, p. 133. Hawaii.
Sierola nigrita Fullaway: 21, p. 120. Oahu.
Sierola nitens Fullaway: 21, p. 148. Oahu, on *Pelea clusiaefolia*.
Sierola nitida Fullaway: 21, p. 77. Oahu.
Sierola notabilis Fullaway: 21, p. 75. Hawaii.
Sierola nubila Fullaway: 21, p. 135. Hawaii.
Sierola nuda Fullaway: 21, p. 157. Oahu.
Sierola oahuensis Ashmead: 3, p. 290. Oahu.
Sierola obscura Fullaway: 21, p. 93. Oahu, Hawaii.
Sierola olinda Fullaway: 21, p. 134. Maui.
Sierola olympiana Fullaway: 21, p. 112. Oahu.
Sierola ooumuana Fullaway: 22, p. 358. On *Glochidion ramiflorum* and *Fagraea berteriana*. Marquesas Islands: Nukuhiva, Hivaoa, Uahuka.
Sierola opaeula Fullaway: 21, p. 105. Oahu
Sierola opogonae Fullaway: 21, p. 122. Reared from *Opogona* larva on *Clermontia*. Oahu.
Sierola osborni Fullaway: 21, p. 91. Hawaiian islands: Hawaii.
Sierola peleana Fullaway: 21, p. 86. Oahu, on *Pelea clusiaefolia*.
Sierola pembertoni Fullaway: 21, p. 140. Oahu.
Sierola perkinsi Fullaway: 21, p. 151. Hawaii.
Sierola perottetiae Fullaway: 21, p. 151. Reared from decaying wood of *Perottetia sandwicensis*. Oahu.
Sierola philodoriae Fullaway: 21, p. 146. Reared from larva of *Philodoria splendida*. Oahu.
Sierola picea Fullaway: 21, p. 104. Oahu.
Sierola pilifera Fullaway: 21, p. 123. Oahu.
Sierola pilosa Fullaway: 21, p. 89. Molokai.
Sierola planiceps Fullaway: 21, p. 146. Oahu.
Sierola polita Fullaway: 21, p. 120. Oahu.
Sierola proxima Fullaway: 21, p. 152. Oahu.
Sierola pubescens Fullaway: 21, p. 97. Oahu.
Sierola pulchra Fullaway: 21, p. 97. Reared from leaf miner in *Urera*. Oahu.

Sierola punctata Fullaway: 21, p. 103. Oahu.
Sierola puuwaawaa Fullaway: 21, p. 128. Hawaii.
Sierola pygmaea Fullaway: 21, p. 108. Oahu.
Sierola quadriceps Fullaway: 21, p. 138. Hawaii.
Sierola robusta Fullaway: 21, p. 124. Oahu.
Sierola rocki Fullaway: 21, p. 81. Hawaii.
Sierola rufignatha Fullaway: 21, p. 115. Oahu.
Sierola rufomandibulata Fullaway: 21, p. 156. Oahu.
Sierola rugulosa Fullaway: 21, p. 110. Oahu.
Sierola scoriacea Fullaway: 21, p. 101. Hawaii.
Sierola seminigra Fullaway: 21, p. 98. Oahu.
Sierola sericea Fullaway: 21, p. 124. Maui.
Sierola setosa Fullaway: 21, p. 125. Oahu.
Sierola sima Fullaway: 21, p. 76. Hawaii.
Sierola similaris Fullaway: 21, p. 126. Oahu.
Sierola similis Fullaway: 21, p. 136. Oahu.
Sierola spicata Fullaway: 21, p. 76. With variety *hawaiiensis*. On *Straussia kaduana*. Oahu, Hawaii.
Sierola strebiognatha Fullaway: 21, p. 104. Hawaii.
Sierola striata Fullaway: 21, p. 107. Oahu.
Sierola subcrispa Fullaway: 21, p. 157. Oahu.
Sierola suttoniae Fullaway: 21, p. 80. On *Suttonia lessertiana*. Oahu.
Sierola swezeyi Fullaway: 21, p. 116. Oahu.
Sierola tahuataensis Fullaway: 22, p. 360. On *Vaccinium, Cyrtandra, Sclerotheca,* and *Cyathea* species. Marquesas Islands: Uapou, Tahuata.
Sierola tantalea Fullaway: 21, p. 90. Oahu.
Sierola tauraaiana Fullaway: 22, p. 361. Marquesas Islands: Hivaoa, beaten from *Scaevola* and *Freycinetia* species. With variety *pukokiana* from Nukuhiva.
Sierola tenebriosa Fullaway: 21, p. 112. Oahu.
Sierola tenuiceps Fullaway: 21, p. 148. Oahu.
Sierola tenuis Fullaway: 21, p. 94. Oahu.
Sierola testacipes Cameron: 13, p. 556.—Ashmead: 3, p. 291. Hawaii, Kauai, Lanai, Maui, Molokai, Oahu.
Sierola timberlakei Fullaway: 21, p. 96. Reared from larvae of *Batrachedra sophroniella*. Oahu.
Sierola tuberculata Fullaway: 21, p. 130. Oahu.
Sierola tumidoventris Fullaway: 21, p. 109. Oahu.
Sierola usitata Fullaway: 21, p. 87. Oahu.
Sierola vestita Fullaway: 21, p. 114. Oahu.
Sierola vetusta Fullaway: 21, p. 143. Maui.
Sierola vitiensis Fullaway: 21, p. 158. Fiji: Rewa.
Sierola volcanica Fullaway: 21, p. 74. Hawaii.
Sierola vulcana Fullaway: 21, p. 133. Hawaii.
Sierola waianaeana Fullaway: 21, p. 155. Oahu.
Sierola willardi Fullaway: 21, p. 158. Oahu.
Sierola williamsi Fullaway: 21, p. 138. Oahu.
Lithobiocerus vagabundus Bridwell: 8, p. 36. Oahu.

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THE HAWAIIAN SILVERSWORDS

Systematics, Affinities, and Phytogeographic Problems of the Genus Argyroxiphium

By

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BERNICE P. BISHOP MUSEUM

OCCASIONAL PAPERS

VOLUME XI, NUMBER 19

HONOLULU, HAWAII

PUBLISHED BY THE MUSEUM

March 20, 1936

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INTRODUCTION

Theories as to the origin of the Hawaiian islands and the derivation of their flora and fauna have appeared with frequency and aroused the greatest interest among biologists. Probably no other region in the world has developed so extraordinary a degree of endemism, which, according to Hillebrand (9)[1], for the indigenous vascular plants is 75.93 percent. Much more recent figures for the indigenous flowering plants given by Campbell (5) reach the remarkable figure of 90.4 percent! This endemism is directly connected with the fact that the Hawaiian Archipelago is the most isolated area of equal size in the world.

There have been many advocates of the theory that the Hawaiian islands are of oceanic origin, that they were elevated from the bottom of the ocean by volcanic action, and that they have always been completely isolated. Others have taken the opposing view that the islands have not always been so isolated, but may even be considered of continental origin. Those with the latter viewpoint believe that the present archipelago represents but the tips of volcanic mountain masses superimposed upon a large block that has undergone subsidence. For instance, Campbell (4) believes there may have been a more or less direct connection with other parts of Polynesia by means of one or several large land masses that possibly approached continental dimensions. Pilsbry (12) adds important support to this view by his study of the land snails, and there are many other faunistic data that give credence to it. A great weight of plant evidence favors a Polynesian-Australian and Indo-Malaysian origin for almost all of the Hawaiian flora. However, a Hawaiian land connection with America has been suggested upon occasion and an

[1] Numbers in parentheses refer to Literature cited, p. 29.

American derivation of the Hawaiian flora has had its advocates. Brown (3) has gone the farthest in proposing an American origin for the bulk of the flora through the agency of ocean currents, and Guppy (8) looked to America for the source of the Hawaiian endemic genera, which he supposed were chiefly spread through the agency of birds. The views of Brown have been strongly challenged by Skottsberg (14), and those of Guppy by Campbell (4) and by Skottsberg.

It will doubtless appeal to the great majority of botanists that the peculiar autochthonous flora of Hawaii could only have developed to its present degree of morphological isolation over a long period of time. Skottsberg (15) emphasizes that the Hawaiian flora has the characteristics of great age. Not only is the number of endemics large, but many species appear to be on the verge of extinction because of their lack of plasticity. Even the flora of the youngest Hawaiian mountains is very old, with 91 percent of the species endemic. This is not easily explained by those who regard the Hawaiian islands as purely oceanic in origin and the flora as carried there from great distances across the ocean, for these alpine regions ought to present favorable conditions for the establishment of new arrivals. But the fact is that, aside from the influence of man, overseas migration has practically ceased altogether. The question arises whether the flora at any time came from a great distance via overseas migration, or whether it dates from a time when the islands were much less isolated than they are now. The flora may not have been developed entirely on the existing islands, pioneering again and again on the upbuilding lava, but it may have existed for eons on adjacent soils that have since become submerged.

Floristic Connections between Hawaii and America

All botanists agree that there is an American element present in the Hawaiian flora, but most would admit that it composes a very small percentage of the whole. The plants assigned to American origin by most authors may be divided into two classes: first, a recent element that is represented by endemic species of genera common to Hawaii and the New World, but not found elsewhere; and second, a group of endemic genera in the Hawaiian Archipelago whose nearest affinities have appeared to be in the New World, but whose connections have often been quite obscure. The second group

must be older than the first, because its affinities have become obscured by the widening differences between its present day representatives and the ancestral stock, and because the species within the genera are usually well-marked, rather static, and senile in character. Campbell (4) has pointed to the comparative youth of the American Compositae that supposedly represent the ancestral stock of several Hawaiian endemic genera as an indication that this latter element in the Hawaiian flora is relatively modern. The present study has made it clear to me that these Hawaiian Compositae are probably not of American origin, which relieves us of the responsibility of attributing youth to these genera, which, by their peculiar development of unique features, as well as by their distribution upon the islands, apparently reflect a great age. From cutting the supposed phylogenetic ties that link the very ancient Hawaiian endemics with the New World and retying them elsewhere, an advantage accrues not only to our phylogenetic system but to the clarification of problems concerning the derivation of the Hawaiian flora. In short, it is possible to follow one's inclinations and agree with Campbell (4, 5), Skottsberg (14, 15), and others that the endemic element in the Hawaiian flora, at least so far as the flowering plants are concerned, is for the most part of great age, and that it may have had its beginnings on nearby land masses in the Pacific even before the present archipelago became habitable. As a corollary to this statement it may be added that the only wave (or ripple) of invasion from the New World seems to have occurred not earlier than the late Tertiary, doubtless long after the islands had attained isolation.

The ancient group of endemic genera supposedly of American origin is composed largely of Compositae. I have confined myself to a study of some of these genera and do not wish to offer critical judgments beyond this family; but as the remaining controversial cases are few, I shall point out possible explanations here also, which it is hoped will attract the critical attention of specialists in these groups.

The endemic Hawaiian genera which have been considered of American origin include *Charpentiera* of the Amaranthaceae, *Isodendrion* of the Violaceae, *Nothocestrum* of the Solanaceae, *Kadua* of the Rubiaceae, and *Argyroxiphium, Wilkesia, Dubautia, Railliardia,* and, of a more doubtful American relationship, *Lipochaeta, Campylotheca,* and *Remya,* all of the Compositae. *Charpentiera* is

placed by Schinz (13), in his recent treatment of the family, between several Old World genera. *Isodendrion* combines capsular fruit and actinomorphic flowers which, with other features, leaves it a genus distinct unto itself. In Melchior's treatment (11), it is placed in a monotypic subtribe following a subtribe with berry fruit that has a New Zealand-Australian distribution. But it is perhaps closer akin to the subtribe of slightly zygomorphic South American forms that Melchior places after it. This genus, together with the Hawaiian shrubby species of *Viola*, points as strongly toward an American relationship as any example, and yet the connections are so indistinct here that an American origin for these forms probably cannot be proved. *Nothocestrum* is placed by Wettstein (17) adjacent to *Withania* of the Old World tropics and *Physalis* of the New World. Since it agrees with the former in woody habit, there seems no reason for continuing to suppose this genus is of American origin. *Kadua* has a recognized affinity with *Oldenlandia* through the latter's section *Hedyotis,* which occurs in the Malaysian region. *Argyroxiphium, Wilkesia, Dubautia,* and *Railliardia* I shall discuss in more detailed fashion below, but it may be noted here that their affinities are considered Pacific rather than American. *Lipochaeta, Campylotheca,* and *Remya* I have not examined, but the origin of the first two named appears to be quite as likely in the Old World as in the New, through their affinities with *Wedelia* and *Bidens* respectively. The latest treatment of *Lipochaeta,* by Sherff (16), lists 26 species, of which one is from the Galapagos Islands, another from New Caledonia and adjacent islands, the remainder being Hawaiian. The genus is therefore scattered across almost the entire width of the Pacific Ocean. *Remya* seems to be a genus so thoroughly distinct that the tracing of its phylogeny has become too much a matter of speculation. It occupies a dubious position in the Astereae-Solidagininae next to the American genus *Grindelia,* from which it might well be displaced by a later monographer.

This narrows the group of ancient Hawaiian endemics with New World affinities to those old species of genera common only to both. I have but a single example in this category, *Vallesia* of the Apocynaceae. This genus has six described species; one in the Hawaiian islands, two endemic in Mexico, one in Mexico and Guatemala, one in Santa Domingo, and one that extends from Florida and Lower California to Peru. Such a distribution indicates that the genus is not

young. Possibly the Hawaiian species is a relatively young member of the genus, and its origin was in America. But on the other hand it is significant that the genera related to *Vallesia* are Polynesian, Australian, Hawaiian, or Asian, and so the theory must be considered that this genus had its origin in the region where its affinities occur, that it has undergone eastward migration, and that the Hawaiian representative never started from America.

The remaining Hawaiian species with undoubted American affinities I judge are of an appreciably younger age than the preceding cases, at least of later arrival in the islands. *Asplenium fragile* Presl, *Pellaea ternifolia* Fée,[2] and *Fragaria chilensis* Duchesne are species indigenous in America and Hawaii. The following are Hawaiian representatives of otherwise American genera: *Sisyrinchium acre* Mann, *Hesperocnide sandwicensis* Weddell, *Sanicula sandwicensis* Gray, *Nama sandwicensis* Gray, *Sphaeele hastata* Gray, and *Aster divaricatus* variety *sandwicensis* Gray. It is possible that other cases have been overlooked, but the preceding data indicate that the total American element in Hawaii is very inconsequential in a flora of some 1,100 species of flowering plants, and that such representatives as have bridged the tremendous expanse of water between did so in accidental manner, probably in most instances since the present highest Hawaiian mountain peaks have become habitable.

Relationships of Argyroxiphium

Asa Gray (7a) was the first to point out some similarities between *Argyroxiphium* and the Madinae, a subtribe of the Helianthoideae, as follows:

> The genus [Argyroxiphium] should be referred to the division Madieae (a group which belongs entirely to the western side of America, principally to California, and of which the radical leaves of some California species exhibit a somewhat similar silky covering) on account of the nearly obsolete pappus of the ray-achenia, and their inclosure in the involute scales of the involucre, and because there is an inner series of scales interposed between the ray-flowers and those of the disk.

Succeeding authors have subscribed to Gray's view and have placed *Argyroxiphium* in the subtribe Madinae. The present writer, engaged with others in a detailed investigation of the Madinae, undertook the systematic revision of *Argyroxiphium,* which here is under-

[2] Additional data from the Cryptogams has not been sought.

stood to include *Wilkesia,* with the expectation of treating it in the monograph on the Madinae in preparation. For reasons detailed below, *Argyroxiphium* is excluded from the Madinae and, consequently, is here presented in a detached treatment.

Argyroxiphium is understood by me to have no direct connection with the Helianthoideae-subtribe Madinae. Those characters mentioned above, by which Gray placed it in the Madinae, are outweighed by the dissimilarities between the two. On the other hand, the evident similarity between *Argyroxiphium* as here circumscribed and *Dubautia* and *Railliardia* of Helianthoideae-subtribe Galinsoginae has not received more than cursory mention. Bentham (2) followed Gray's disposal of *Wilkesia* and *Argyroxiphium,* placing them as the first two genera in his tenth subtribe, Madieae. These followed *Dubautia,* the last genus in his ninth subtribe, Galinsogeae. Bentham neglected to note the very evident similarities and relationship between *Dubautia* and *Railliardia,* placing the latter genus in a remote position in the Senecionideae, three tribes away. This disposal of *Railliardia* was changed by Hoffmann (10), who returned it to the subtribe Galinsoginae as the last genus, following *Dubautia.* Hoffmann retained Bentham's order for *Wilkesia* and *Argyroxiphium* at the head of the Madinae.

I propose to insert *Argyroxiphium,* which is here defined to include *Wilkesia,* into the Galisoginae in front of *Dubautia,* with which it has more points in common than with *Railliardia.* This does not obscure the line through *Dubautia* and *Railliardia* to the Senecioneae, a transition suggested by Hoffmann (10), and plausible from a consideration of pappus and involucre, to which there is reason to suppose the connection may be less remote than from *Argyroxiphium* to the Madinae.

The large, nodding heads of *Argyroxiphium* are not at all closely duplicated in the Madinae, while its purple ray-flowers, hardened pappus scales, and involucral bracts are of types likewise foreign to the Madinae. The following tabulation indicates the distribution of the most important characters between these genera and shows that *Argyroxiphium* has more points of agreement with *Dubautia* and *Railliardia* than with the Madinae.

MADINAE	ARGYROXIPHIUM (Including WILKESIA)	DUBAUTIA AND RAILLIARDIA
Heads heterogamous	Heads heterogamous or homogamous	Heads homogamous
Ray-akenes enclosed by their enfolding bracts	Ray-akenes (when present) merely subtended by concave but not enfolding bracts	Ray-akenes none
Herbs (mostly annuals); few shrubby species	Shrubs or small trees	Shrubs or small trees
Leaves not clustered at ends of stems in perennial species	Leaves clustered at ends of woody stems, which are marked with prominent leaf-scars	Leaves often clustered at ends of woody stems, which are marked with prominent leaf-scars
Involucral and receptacular bracts unlike, not adnate, often connate	Involucral and receptacular bracts alike, ± adnate; receptacular bracts connate	Involucral (and receptacular) bracts alike, usually in one series, ± connate
Filaments not pustulate-thickened at base of anthers	Filaments pustulate-thickened at base of anthers	Filaments pustulate-thickened at base of anthers
Style-branch appendages not abruptly differing from stigmatic portion, long, attenuate	Style-branch appendages thickened and short, acute	Style-branch appendages usually very short, acute
Habitat in western North America, one species extending south through Chile to Patagonia	Habitat in Hawaiian islands	Habitat in Hawaiian islands

Tracing further the connection between *Argyroxiphium,* on the one hand, and *Dubautia* and *Railliardia,* on the other, it must be admitted that differences in inflorescence, head size, and pappus are so pronounced as to indicate an ancient separation between the groups. But the agreement in shape, texture, venation, arrangement and fall of leaves in *Argyroxiphium Grayanum* and *Dubautia plantaginea,* for example, is certainly suggestive, although not conclusive evidence, of relationship. Similarities in the androecium and gynoecium are of more importance in this connection. Both *Argyroxiphium* and *Dubautia* have at least some rosette-tree life forms. The

connection between the habitats of the three genera should also be pointed out, *Argyroxiphium* being chiefly alpine, *Dubautia* and *Railliardia* montane with alpine representatives.

Bentham (1, p. 446) has pointed out that the Madinae is a transition group between Helianthoideae and Helenioideae and that the members of the Galinsoginae have formerly been classed under the Helenioideae. To be sure, the numerous transitions and recombinations of key characters make it very difficult to maintain clear-cut tribes in this phylogenetically unified portion of the great family Compositae. The problem often becomes more acute when the boundaries of the subtribes are to be set. Synantherologists, without hesitation, link many genera together which have an evident relationship regardless of the fact that exceptions to the key characters must be admitted; and they likewise apply group names to these assemblages, such as the subtribal one, in spite of the necessity for fallible definitions of the groups. These facts should be borne in mind in weighing this realignment of the Galinsoginae and Madinae. I feel that the Madinae becomes a definitely more natural subtribe by the exclusion of the Hawaiian species, and certainly no violence is done by placing the latter with their Hawaiian neighbors in the Galinsoginae.

Argyroxiphium, Dubautia, and *Railliardia* would appear to constitute an insular group unto themselves, all being endemic, and probably without close relatives. I admit no evident relationship between the first of these and the Madinae, nor am I able to concur at all with Asa Gray's view that *Railliardia* and *Raillardella* are so closely related that the latter may be treated as a section of the former. It would seem Gray was placing too much emphasis on parallel variation in style-appendages and pappus, and too little on the tremendous dissimilarities of habit, inflorescence, and distribution, when this proposal was made. If the affinities of these genera are totally within the Helianthoideae, it is possible that their origin is American; but if, on the other hand, their relationship lies with the Senecioneae, a possibility by no means excluded at present, their ancestral line may extend toward a southwestern, rather than an eastern, origin.

In checking Bentham's placement of *Railliardia* adjacent to *Robinsonia* and *Rhetinodendron,* closely related endemic genera of Juan Fernandez and universally regarded as members of the Senecioneae, one finds there is a strong resemblance between *Robinsonia* and some

species of *Dubautia* in growth form (both being small rosette-trees), foliage, inflorescence, androecium, etc., but other differences are so profound as to discourage the claim of an intimate connection between the two. In the case of such relict genera it is not to be expected that always morphological similarities can be discovered in organ after organ, even in the next of kin, or that always satisfactory phylogenetic connections can be traced. With this in mind we may ponder Skottsberg's suggestion (15, p. 56):

> By way of *Dubautia* these genera [*Argyroxiphium* and *Wilkesia*] are perhaps connected with *Railliardia* and this with *Robinsonia* of Juan Fernandez, which has a recently discovered close relative in the mountains of New Guinea, *Brachionostylum* Mattfeld.

This resemblance, or one with such a genus as *Bedfordia* of Australia, is sufficiently arresting to indicate that the affinities of these genera are to be found to the south or southwest in the Pacific. Certainly the morphological gaps are at least as large or larger between these and any of their suggested American affinities. By thus divorcing *Argyroxiphium* from the American genera to which it has been thought related, the most persistently proposed connection between the ancient element in the Hawaiian flora and the New World has been shattered.

Argyroxiphium versus Wilkesia

Ever since its proposal as a genus, *Wilkesia* has been separated chiefly on the basis of its discoid heads from *Argyroxiphium,* in which the heads are radiate. In this case it has been generally assumed that the absence of ray-flowers represents a loss through reduction and that accordingly *Wilkesia* is the derived group. A series may be arranged on the basis of number of ray-flowers starting with *Argyroxiphium sandwicense,* which has the most, through *A. virescens* and *A. caligini* with progressively fewer, and *A. Grayanum* with an occasional radiate head, to *Wilkesia gymnoxiphium,* which has no trace of a ray-flower. It was very recently mentioned that *A. Grayanum* had ray-flowers. Degener called my attention to the fact and sent me some heads for substantiation. Since then I have discovered at least one or two ray-flowers on several sheets of this species; but in most heads there are none, and the inconspicuous ligule aids them in escaping detection. Before this

discovery it was apparent that the plant then called *Wilkesia Grayana* agreed with the species of *Argyroxiphium* in phyllotaxy, inflorescence, disk-flowers, pappus, and habitat. That it has ray-flowers, even though rarely, shows it rightfully belongs with the true Argyroxiphiums rather than with the isolated Kauai endemic, *Wilkesia gymnoxiphium.*

In addition to the ray-flower character, the distinctness of *Wilkesia* as a genus has been greatly weakened by a consideration of other characters of first importance. So, after taking into account its close connection with *Argyroxiphium* and its distant relationship elsewhere, the position of *Wilkesia* as a monotypic genus seems to have become untenable. I have followed the course of retaining *Wilkesia* as a section under *Argyroxiphium* by which the obvious genetic relationship that exists here is emphasized. Even with this inclusion, *Argyroxiphium* remains sufficiently small to reveal at a glance what is contained within it. After all, the strongest argument is that, considering the transitional position of *A. Grayanum,* there are no characters of generic value remaining on which to retain two genera.

Morphologically, *A. Grayanum* serves as a link to connect the other species of section *Euargyroxiphium* with section *Wilkesia.* Its rosette leaves on pressed specimens always appear to be arranged in a continuous close spiral; but Hillebrand (9) asserts that they are verticillate in young plants. In *Wilkesia* the leaves are verticillate throughout, while in *Euargyroxiphium* they are spiral, probably even in the youngest rosettes. In *A. Grayanum,* too, there is a tendency for the leaves to be connate at their very bases, and their blades are flat and veined, all of which are reminiscent of *Wilkesia.* In habit, the dwarf rosette-tree of *A. Grayanum* is intermediate between the much taller *A. gymnoxiphium* and the epigeous rosettes of the other species.

The specificity of habit in these plants has not been sufficiently emphasized. Degener (6, p. 308) notes that *A. caligini* " . . . is characterized by dividing and creeping profusely over the ground and progressively dying back at the base, thus isolating the branches into independent plants." *Argyroxiphium sandwicense* and *A. virescens* do not creep. The former is almost without exception a monopodial hapaxanthic rosette-shrub; the latter is more frequently sympodial but limited in its branching to a second rosette (6). The rosette-

trees, *A. Grayanum* and *A. gymnoxiphium,* are apparently monopodial in the majority of cases.

Materials

There have been available for this study the collections in the herbaria of the following institutions, indicated in citations by the abbreviations in parentheses: Bernice P. Bishop Museum, Honolulu (Bish); University of California, Berkeley (C); California Academy of Sciences, San Francisco (CAS); Field Museum of Natural History, Chicago (F); Gray Herbarium of Harvard University (GH); Missouri Botanical Garden, St. Louis (M); New York Botanical Garden (NY); Academy of Natural Sciences, Philadelphia (Ph); Dudley Herbarium of Stanford University (SU); United States National Herbarium, Washington (US). To the custodians in charge of these collections I wish to express my most sincere thanks for their assistance. In addition, I wish particularly to acknowledge the help given by Mr. Otto Degener, of Honolulu, whose private herbarium (Deg) contains much unduplicated material, and who supplied not only herbarium specimens but liquid material of three species and valuable notes based upon his field experience with these plants. For similar observations and material I owe my thanks to Mr. Ray Fosberg, of the University of Hawaii, Dr. Herbert E. Gregory, Director of Bernice P. Bishop Museum, and Dr. G. M. Smith, Stanford University, kindly helped me obtain the habit photographs used in illustration.

The genus *Argyroxiphium* is composed of narrowly endemic species that do not blossom regularly and consequently are poorly represented in the herbaria in flowering stages. This paucity of material tends to mask the complete intergradation of the variations that exist in many characters, as shown when full series of specimens are assembled. It is regrettable that there is no evidence to offer, either from breeding, cytology, or published field observations concerning hybridization, which is here considered to have taken place more than once between two pairs of species.

SYSTEMATIC ACCOUNT OF ARGYROXIPHIUM

Argyroxiphium De Candolle, Prodr., vol. 5, p. 668, 1836.

Argyrophyton Hooker, Comp. Bot. Mag., vol. 2, p. 163, 1836; Icon. Plantarum vol. 3, pl. 75, 1836.

Subacaulescent to arborescent perennials; caudex stout, woody, medullary, simple or divided, not elongated, or forming more or less elongated creeping woody stems, or consisting of an erect trunk, crowned with a dense rosette of spirally or verticillately arranged ensiform entire rigid longitudinally nerved leaves, hapaxanthic, at length elongating to produce an ample erect raceme or panicle. Heads many, large, heterogamous or homogamous, nodding after anthesis. Involucre (or what corresponds to it) campanulate to hemispheric or urceolate; bracts of true involucre uniseriate or none, when present equal, herbaceous, narrow, the thin ciliate margins ± enfolding the akene; bracts surrounding the disk (receptacular cup) united, uniseriate, the convex or conical receptacle otherwise naked and glabrous. Ray-flowers, when present, several or few, pistillate, fertile; ligules purplish or yellowish, 3-fid. Disk-flowers many, hermaphrodite, fertile; corolla tubular or somewhat flaring at throat, yellow, the 5 regular deltoid lobes about 0.5 mm long; style-branches with penicillate-tufted conical appendages. Ray akenes, when present, broadly linear, somewhat arcuate, 4- or 5-angled, blackish; areola slightly eccentric, calloused and surmounted with a corneous cyathiform pappus. Disk-akenes similar to ray akenes, prismatic, with or without a pappus of a few short fimbrillate cartilaginous ± united paleae. Type species: *A. sandwicense* De Candolle.

A genus endemic in the Hawaiian islands.

Key to Sections

A. Leaves spirally arranged, becoming alternate above, not united into a sheath at base; peduncles alternate, ascending; inflorescence racemose; involucre campanulate to hemispheric; ray-flowers present (usually none in *A. Grayanum*); akenes glabrous ..... I. **Euargyroxiphium**

AA. Leaves verticillate throughout, united into a sheath at base; peduncles verticillate, widely divaricate; inflorescence paniculate; involucre urceolate-campanulate; ray-flowers none; akenes pubescent ..... **II. Wilkesia**

Section I. EUARGYROXIPHIUM Keck, new section.

A section composed of four species that are confined to the islands of Maui and Hawaii.

Key to Species

A. Caudex not elongated, rarely forked; heads large, involucre 12-35 mm in diameter; ligules of ray-flowers 6-8.5 mm long, purplish; rosettes 20-80 cm in diameter.

B. Leaves silvery floccose, glistening, subtriquetrous; ray-akènes 5-angled, not geniculate apically.....1. **A. sandwicense**

BB. Leaves greenish, not floccose, thinner, ray akenes 4-angled, slightly geniculate apically .....2. **A. virescens**

AA. Caudex elongated, branching; heads smaller, involucre 10-15 mm in diameter; ligules of ray-flowers 4 mm or less long, or sometimes none; rosettes 6-20 cm in diameter.

C. Leaves silvery floccose, slender, thick; stems creeping with epigeous rosettes; ray-flowers always present, purplish.....3. **A. caligini**

CC. Leaves green, broad, flat; stems erect, forming a dwarf rosette-tree; ray-flowers usually obsolete, yellow.....4. **A. Grayanum**

1. **Argyroxiphium sandwicense** De Candolle (pls. 1, *a-g*, 2, 3, 4, 5).
   Argyroxiphium sandwicense De Candolle, Prodr., vol. 5, p. 668, 1836; and De Candolle, Coll. Mem. IX. Comp., pl. 8, 1836.
   Argyrophyton Douglasii Hooker, Comp. Bot. Mag., vol. 2, p. 163, 1836, nomen subnudum; and Hooker, Icon. Plantarum, vol. 3, pl. 75, 1836.
   Argyroxiphium macrocephalum Gray, Am. Acad., Proc., vol. 2, p. 160, 1852; emend. vol. 5, p. 137, 1861. Type locality: "On the island of Maui, at the base of a high crater." This crater is Haleakala.

Gray distinguished *A. macrocephalum* from *A. sandwicense* on the basis of its larger heads, the total absence of pappus, and the conical receptacle. Hillebrand, in reducing this species to a variety of *A. sandwicense,* pointed out that his specimens from the type locality had perfectly developed pappus, but he stated that the variety differed from the species in having shorter ligules, and longer appendages of style-branches. The largest heads I have studied are on Forbes 880.H, from Mauna Kea, and are of the maximum size described for *A. macrocephalum.* Almost all cited specimens from Haleakala, on Maui, are from somewhat to very much smaller and well correspond with the description of *A. sandwicense.* These specimens show that on Haleakala some plants have abundant disk-pappus, some have no, or at most vestigial, pappus, and the evidence seems clear that such differences in pappus may exist in adjacent plants. The occurrence of pappus is so irregular as to number and size of the paleae that it is unwise to place taxonomic significance on the various degrees of its presence or absence. I have not found appreciable differences in the length of ligules or style-branch appendages. It is true that the extremely large heads of the Forbes 880.H collection had much more conical receptacles as a correlated feature.

But there is no correlation between head size and pappus, or between either of these characters and geographic distribution. So, *A. macrocephalum* would have to stand or fall on the basis of head size. A survey of the collections indicate that this character varies by gradual steps from one extreme to the other. Hence this name is necessarily relegated to synonymy without qualification.

A. sandwicense variety **macrocephalum** Hillebrand, Fl. Haw. Isls., p. 219, 1888.

Caudex 2-5 cm thick from a strong branched taproot, about 3-10 cm long, covered with dark-brown bark as much as 5 mm thick, the very rigid leaves forming a rosette 3-8 dm in diameter. Flowering stem 8-20 dm high, medullary, 4-8 cm thick at base, silvery tomentose below, glandular-pubescent and tawny above. Leaves of rosette arcuate-ascending, subtriquetrous, attenuate to the narrow but blunt tip, 10-40 cm long, 4-10 or 15 mm wide, very densely sericeous-floccose and silvery white; leaves of flowering stem similar, more horizontal, gradually reduced in size upward, the upper leaves viscid-pubescent at base, the very copious tomentum more and more confined to the apical portion. Raceme heavy, oblong, bearing 100-200 or more heads; peduncles 6-30 cm long, glandular-pubescent, with 2-6 or more equally spaced linear foliaceous bracts along their axes. Involucre hemispheric, 10-15 mm long, 15-35 mm broad; bracts linear, attenuate, 1.5-2.5 mm wide across the rounded back, densely glandular-pubescent, sometimes adnate toward base to inner bracts. Ray-flowers 10-30 or more; ligules moderately conspicuous, purple, about 6-12 mm long, 2-3.5 mm wide, oblong, the linear lobes up to 4 mm long; tube 3.5-6 mm long. Bracts of the disk somewhat exceeding the rays in number, connate about half way into a cup, each bract shallowly concave, thick, acuminate, viscid-pubescent without. Disk-flowers commonly more than 100, probably 300-400 in largest heads; corolla glabrous, or pubescent on tube, 5-6 mm long. Ray-akenes 7.5-12 mm long, usually 5-angled, not geniculate apically. Disk-akenes similar. Pappus of the ray-akenes coroniform, or of 1 or 2 minute paleae, or none; that of the disk-akenes none, or vestigial, or present and 1-5 mm long; paleae 5-10, more or less united, linear to quadrate, unequal, stramineous.

Known only from the islands of Hawaii and Maui. Type locality: " . . . in insulis Sandwicensibus ad Owyhee floridam mense junio legit cl. Macrae."

Hawaii, Mauna Kea: Wilkes Expedition (GH, Ph, US); 10,100 feet, Rock 8434 (Bish); source of Wailuku River, Forbes 880.H (Bish, C, F, M, SU, US); Kukaiau Ranch, 8,000-11,000 feet, Hitchcock 14280 (Bish, US).—Hawaii, (Mauna Loa): Kaa, Pohina, Kau, August 29, 1922, Meinecke (Bish); above Kapapala, Kau, Forbes 430.H (Bish). Also reported from Hualalai.

Maui, Haleakala Crater: Forbes 302.M (Bish, C, CAS, F, M, SU, US); 10,000 feet, Reed (C); Hitchcock 14949, 15570 (US); Rock

8608 (Bish, GH), 8608a, 10317 (Bish); Weaver 22 (Bish); Hillebrand and Lydgate (Bish); on cinder cone, Degener 3527 (Deg, SU); 8,100-10,000 feet, Mann and Brigham 370 (Bish, M); Sliding Sand Trail and lava beds at foot, on the side of a cinder cone, 2,450 meters, Fosberg 10002 (Bish, SU); Haleakala, Wilkes Expedition (US, type of *A. macrocephalum* A. Gray; isotype GH).

I have studied a few flowers taken by H. M. Hall in 1925 from the only sheet of the species in the De Candolle Herbarium. Hall considered this sheet the type and noted that there were no clear data with it. The type was taken in June by Macrae.

This species is among the most outstanding of the native flora. It is known to thousands by its common name, "silversword", who are as willing to seek for it in its mountain fastnesses as are those who cherished a glimpse of the edelweiss in Switzerland. A sight of the large, silvery-white, spherical rosettes of this species is a feature of the trip to the summit of the very barren and lava-strewn peaks, Haleakala, Mauna Loa, and Mauna Kea. The traditional beauty of the silversword was known to the native Hawaiians, who called it *ahinahina* (gray-headed), because they had never, before the coming of the white man, seen silver, and therefore could not apply to the plant the cognomen that is so appropriate.

This plant blooms from June to October. On the cinders and lava ledges of the alpine region where it grows, it is about the only plant life to be found.

2. Argyroxiphium virescens Hillebrand (pl. 6).

Argyroxiphium virescens Hillebrand, Fl. Haw. Isls., p. 219, 1888.

Caudex from a woody taproot, covered with a thin bark, densely clothed by the slender rush-like but rigid leaves which form a rosette 3-5 dm in diameter, occasionally branching to form a second rosette. Flowering stem 10-15 dm high, medullary, 2-4 cm thick at rosette, tawny and viscid-pubescent throughout. Leaves of rosette erect or ascending, subtriquetrous, attenuate to the very acute tip, 10-30 cm or more long, 3-7 or 8 mm wide, green, sericeous particularly marginally, glabrate beneath, lightly pubescent and viscid above; leaves of flowering stems recurved, gradually reduced in size upward, densely viscid-pubescent. Raceme heavy, bearing 30-100 or more large nodding heads; peduncles 6-15 cm long, glandular-pubescent, with 1 or 2 linear bracts along their axes. Involucre broadly campanulate, 10-18 mm long, 12-20 mm broad; bracts linear, attenuate, about 1.5-2 mm broad across the rounded back, adnate to the receptacular bracts for more than half their length, densely glandular-pubescent. Ray-flowers 6-20, unevenly spaced; ligules inconspicuous, pale purplish, about 6 mm long, about 2 mm wide, linear-oblong, the teeth about 1 mm long; tube 3 mm long, pubescent. Receptacle convex, puberulent or glabrate. Bracts of the disk about double the number of the rays, firmly con-

nate most of their length, each bract shallowly concave or plane, cartilaginous, acuminate, viscid-pubescent without. Disk-flowers about 200; corolla pubescent on the tube, 5-6 mm long. Ray-akenes 10-11.5 mm long, slightly geniculate apically, usually 4-angled; areola cup-shaped, the margin denticulate and occasionally bearing a short pappus-scale or two. Disk-akenes similar but not geniculate, 4- or 5-ribbed; areola bearing on the posterior rim a pappus of 2-6 fimbrillate corneous unequal ± fused paleae 2-4 mm long, and bearing on the anterior rim some irregular vestigial teeth, all soon deciduous.

Restricted to the island of Maui and known only from the region of Haleakala. Type locality: "northern slope of Haleakala, from 8,000 to 9,000 feet."

Maui: Remy 284 (GH); Wilkes Expedition (GH, US); Haleakala, Hillebrand (US, possibly isotype); Haleakala, 8,000-9,000 feet, Mann and Brigham 369 (Bish); Haleakala Crater: 6,000-10,000 feet, Hitchcock 14941 (US); Koolau Gap, on fog- and rain-swept moss-covered eroded lava, August 17, 1927, Degener and Topping 3528 (Deg, SU); Puunianiau Crater, Rock 8575 (Bish in part, C, F, GH, US), 8578 (US), 16036 (Bish); edge of Kipahulu, Forbes 1170.M (Bish, C, F, US); Keanae Gap, Forbes 1018.M (Bish, C), 1064.M (US); east of Ukelele, July 1919, Forbes (Bish); southeast of Ukelele, Forbes 1251.M (Bish).

3. **Argyroxiphium caligini** Forbes (pls. 7, 8).

Argyroxiphium caligini Forbes, B. P. Bishop Mus., Occ. Papers, vol. 7, no. 3, p. 38, 1920.

Caudex woody, creeping, several decimeters long and 1-2.5 cm thick, often with several radiating elongated spreading woody stems at apex, consisting of a woody cylinder surrounding a large pith, the thick bark roughened with old leaf-traces, radiating stems rarely again forked, rooting to form isolated plantlets as the old stems die back. Flowering stems 3 or 4 dm high, not woody, slender, white-floccose throughout. Leaves linear, in dense epigeous rosettes 6-20 cm in diameter, plane or subtriquetrous, attenuate to the narrow but blunt tip, 3-13 cm long, 2-4 mm wide, very densely silvery sericeous-floccose; cauline leaves similar, erect, smaller, but prominent to apex of inflorescence, without reduction in the pubescence, not viscid. Raceme narrow, bearing 15-40 or more heads; peduncles 4-8 cm long, green and viscid-tomentose throughout or floccose at base, with a few linear-lanceolate floccose bracts along their axes. Involucre broadly campanulate, green, 8-10 mm long, 10-12 mm broad; bracts broadly linear, acute, about 1.5 mm broad across the rounded back, free, densely glandular-pubescent. Ray-flowers 10 or less, purplish; ligules inconspicuous, about 4 mm long, linear, the teeth less than 1 mm long; tube 1 mm long, glabrous. Bracts of the disk about double the number of rays, firmly united most of their length into a cup, cartilaginous, acuminate, viscid-pubescent without. Disk-flowers many less than 100; corolla glabrous, 4-5 mm long. Ray-akenes about 5 mm long; areola with short beak, shallow, the margin denticulate. Disk-akenes similar, 4- or 5-ribbed; pappus largely

posterior, of 4 to 6 ovate to lanceolate entire more or less united unequal paleae up to 1.3 mm long.

Common on the summits of Mount Eke (Mauna Eeke) and Puu Kukui, western Maui, doubtfully in eastern Maui. Type locality: "Type in the B.P.B.M. Herbarium, No. 391, M, collected on Eke, West Maui, T. H., October, 1917, by C. N. Forbes."

Maui: Mount Eke, Honokahau drainage basin, Forbes 391.M (Bish, type, 2 sheets; isotypes C, F, US); summit of Mount Eke, Degener 2557 (Deg, SU, US); Mauna Eke, Cox 10321 (Bish); Puu Kukui, December 1928, Bryan (Bish); Puu Kukui, in a bog near the summit, 5,400 feet, Yuncker 3484 (F); Haleakala, Rock 10317 (Bish, possibly a young *A. sandwicense*); without locality, Mann and Brigham 616 (Bish).

A clump of about five rosettes radiating on short stalks from a heavy taproot was found on the outer slopes of Haleakala, between the summit of the Halemau Trail and Puu Nianiau, by Fosberg, No. 9975 (Bish), who saw but the one specimen here. It is in the vegetative condition but is unmistakably of this species. The difference in habitat between this "dry brushy slope" and the swamps of Eke and Puu Kukui raises an ecological question difficult to answer. It might be considered that Fosberg's specimen was a waif that had chanced to survive in an environment quite unlike that of the species in West Maui. But on the other hand, certain short-leaved specimens with something of a caudex developed, which have been collected in the Haleakala region, are probably *A. sandwicense* in spite of certain characters of *A. caligini*. These may be the key to Fosberg 9975. It is to be hoped that future collectors can identify these short-leaved rosettes with flowering plants. Possibly it will be necessary to stake several such individuals and await their flowering several years in the future to properly clarify their identity.

Degener (6, p. 308) writes:

This Eke silversword, named *Argyroxiphium caligini* Forbes, is characterized by dividing and creeping profusely over the ground and progressively dying back at the base, thus isolating the branches into independent plants. It does not produce silvery spheres two or more feet through, as does the Haleakala plant. Instead, its mass of leaves is rarely six inches across. Of the many thousand plants growing, all of which could be easily seen, only one showed the remains of a flowering stalk in the late summer of 1927. This was about two feet high. Besides growing on Mount Eke, this plant may be found in small numbers on Puu Kukui, a higher mountain located across a deep ravine to the south.

4. Argyroxiphium Grayanum (Hillebrand) Degener.

Argyroxiphium Grayanum (Hillebrand) Degener, Fl. Hawaiiensis, 344: Argyroxiphium Grayanum, 1936.

Wilkesia Grayana Hillebrand, Fl. Haw. Isls., p. 220, 1888.

Plant to 2.5 m high; stem erect, 0.7-3 cm thick (described by Hillebrand as 3 inches thick at base), rarely forked, the thick bark persistent below, the continuous spiral node and often the fibery remains of leaf-traces prominent above, topped with a green rosette. Leaves in a continuous close spiral, almost free, connate for less than 1 mm, linear-lanceolate, attenuate to base and apex, plane, prominently longitudinally veined, reflexed after raceme elongates, the immature sericeous, the mature glabrous except for the hispid-ciliate margins, 10-25 cm long, 7-18 mm wide; leaves of inflorescence alternate and more remote, equaling the peduncles, glandular-puberulent, yellowish green. Raceme 2-6 dm long with numerous heads; rachis thick, longitudinally ridged, canescent and densely glandular; peduncles 5-15 cm long, densely glandular-pubescent, with 2-4 scattered linear bractlets. Involucre broadly turbinate to hemispheric, 9-12 mm high, 12-15 mm broad, outer (true) involucre nearly obsolete, when present similar and adherent to the inner involucre; bracts firmly connate, glandular-pubescent, the 20-30 free tips 2 5-5 mm long, lanceolate, ciliate, spreading after anthesis. Ray-flowers few, 3-5 per head, or commonly none, yellow; ligules inconspicuous, about 3 mm long, 2 mm wide, the lobes 0.6 mm long; tube 1.8 mm long, pubescent. Disk-flowers 100-200; corolla glabrous, or pubescent only on tube, 4-5 mm long; anthers included. Ray-akenes and disk-akenes similar, about 6 mm long, brown, glabrous, but ray-pappus vestigial. Pappus to 1.8 mm long; paleae 4-8, lanceolate to quadrate, variously fused, stramineous, fimbrillate, the posterior 1 or 2 the longest, the anterior sometimes missing or all reduced to a single palea and a row of minute denticulations or some flowers of the head without pappus.

Endemic on the island of Maui. Type locality: "W. Maui; on the southern slope of Eeka at a height of 5,000 to 6,000 ft."

W. Maui: Mt. Eeka, Aug. 1870, Hillebrand (US, possibly isotype); Mt. Eeka, 4,000-6,000 feet, Hillebrand (GH, possibly isotype); Eke, Honokahau drainage basin, Forbes 392.M (Bish, F); northwest side of Mt. Eke, 50 feet below the summit, on an exposed, fog-swept, precipitous, clay bank, Degener 8011 (Deg, SU). Puu Kukui: 5,000 feet, Hitchcock 14845 (US); 3,000-5,000 feet, Hitchcock 14828 (Bish, US); fringe of open bog, Munro 625 (Bish, C, US); summit, Rock 8196 (Bish, C, GH, NY, US); Forbes 63.M (Bish); Bryan 682 (Bish), between Nakalalua and summit, open bog, Fosberg 10017 (Bish, SU); Haelaau-Puu Kukui trail, Ewart 52 (Bish). Bog below Wai Anapanapa, north slope of Haleakala, Forbes 1235.M (Bish).

Degener writes:

Don't be confused by Hillebrand's statement that the type locality of this species is Mount Eke! He apparently made an error and climbed Puu Kukui

from the town of Lahaina and mistook that mountain for Eke. He never reached Eke. I had great difficulty in doing so, and I had the advantage of crawling in tunnels through mountains to get near Eke. These tunnels had not been built in Hillebrand's time.

Certain sheets of Rock 8196 (Bish, NY, 1 sheet each) were collected to represent juvenile stages of this species. At the same time and under the same number adult specimens were taken. These young plants, with their fifty or more short wirey stems each bearing a rosette of leaves 1 or 2 cm long, appear too different from the adults. It is difficult to visualize them assuming an arborescent habit. It is plausible that these sheets represent this species and that intermediate stages of development were there to guide Rock in making the collection; but it also seems possible that these may represent some species of *Dubautia.*

Hybrids

Two interspecific hybrids are to be reported from the section *Euargyroxiphium.*

Argyroxiphium sandwicense × virescens.

This apparent hybrid has been collected twice on Haleakala, Maui, where both the parents occur. Each collection was made under the same field number as that given one or the other of the parents showing that it grows with both. A large basal rosette of this hybrid, from Puunianiau Crater, Haleakala, composes one sheet of Rock 8575 (Bish), the other material collected under this number being *A. virescens.* One of the sheets at Bishop Museum of Rock 8608, from the crater of Haleakala, collected for and with genuine *A. sandwicense,* is an exact match for the other specimen of this hybrid. Because it does not seem "useful or necessary" to name this hybrid, it is designated by a formula, in accordance with the International Rules of Botanical Nomenclature (1930). The following hybrid, however, is given a name because that name has already been applied to it as a variety.

× Argyroxiphium Kai (A. caligini × Grayanum) (pl. 9).

Argyroxiphium caligini variety *Kai* Forbes, B. P. Bishop Mus., Occ. Papers, vol. 7, no. 3, p. 39, 1920.

This putative hybrid is known only from the bogs at the summits of Puu Kukui and Eke, western Maui, where it occurs with

both the parental species. Degener reports that it is much less frequent than the other two. This hybrid is considered a parallel to *Argyroxiphium sandwicense* × *virescens* that is restricted to eastern Maui. Both are considered to be derived from crosses between a species with silvery leaves and one with greenish leaves; accordingly their resulting pubescence and color, of intermediate character, are closely similar. In habit, × *A. Kai* duplicates *A. caligini,* creeping and branching along the ground with the terminal rosettes isolating into new plantlets as the woody stems die back. In foliar characters the hybrid combines characters from both the parents. Its leaves are considerably less crowded in the rosette than are those of *A. caligini* although they are of the same length and half again as wide. The texture, thinness, and shape of the leaves is similar to the condition in the smaller rosettes of *A. Grayanum.* No ray-flowers have been detected on the two flowering specimens of × *A. Kai* seen, and the pappus of this hybrid is reduced to a solitary posterior tooth or an erosulate margin on the cartilaginous areola.

Because this has been reported as a more or less uniform and abundant type in its two localities, and since data are lacking as to its fertility and behavior of the offspring, the possibility must be considered that this is an allopolyploid species derived through hybridization with the parental species indicated.

Forbes, in describing *A. caligini* variety *Kai,* declared it was of wider distribution than the species. This was due to its discovery on Puu Kukui before *A. caligini* was known to occur there. The type is "No. 391, a. M., collected on Eke, West Maui, T. H., October, 1917, by C. N. Forbes."

Maui: Eke, Honokohau drainage basin, Forbes 391a.M (Bish, type, 2 sheets); northern summit of Mount Eke, rim only, in shrubless clay bog, Degener 3526 (Deg, SU); Puu Kukui swamp, 5,800 feet, Rock 10318 (Bish, GH).

Section 2. **WILKESIA** Keck, new combination.

Wilkesia, as a genus, A. Gray, Am. Acad., Proc., vol. 2, p. 160, 1852; emend. vol. 5, p. 136, 1861. Named in honor of Capt. Charles Wilkes, commander of the United States South Pacific Exploring Expedition.

A monotypic section, the single species endemic on the island of Kauai.

5. Argyroxiphium gymnoxiphium (A. Gray) Keck, new combination.

Wilkesia gymnoxiphium A. Gray, Am. Acad., Proc., vol. 2, p. 160, 1852.

Plant 1.5-4 m high including the panicle of 5-10 dm; stem erect, simple or (rarely?) verticillately branched, leafless below the crowning rosette, 1-3 cm thick, consisting of a thin wooden cylinder surrounding a firm pith, the brown bark longitudinally ridged, the prominent annular nodes 3-15 mm apart, glabrous or canescent. Leaves verticillate, 10-20 at a node, their bases connate into a sheath 2-6 cm long and overlapping several younger nodes, the blades linear, attenuate, plane, erect, the immature somewhat sericeous, the mature glabrous except for the densely sericeous margins, 15-40 cm long, 5-10 mm wide, light green. Thyrse of 10-20 nodes, verticillate, to 5 dm in diameter at base, often bearing to 300 heads, internodes to 5 cm long, longitudinally ridged with peduncular traces, very resinous and beset with numerous stipitate yellow glands; bracts abruptly differing from foliaceous leaves, verticillate, about 10-12 at a node, connate-perfoliate, forming a cup about 1 cm deep, free portion broadly lanceolate, the lowermost 5-8 cm long and 15-20 mm wide, the uppermost shorter and usually broader, glabrous except for the sericeous margins, each bract subtending a peduncle; peduncles simple or, more often, dichotomously forked to bear 2 (sometimes 3-5 on lowermost) heads on pedicels 1/3 as long, widely divaricate, slender, densely glutinous and stipitate-glandular, ebracteate or pedicel sometimes subtended by one or more linear bractlets. Involucre urceolate-campanulate, 9-14 mm high and as broad; bracts firmly united for most of their length to form a smooth but viscid cup, the 20 or so free tips 1-3 mm long, very unequal, lanceolate, strongly villous-ciliate, at anthesis erect, at fruiting spreading. Disk-flowers 100-225; corolla yellowish, pubescent only on lobes, 6-7 mm long; anthers exserted. Akenes 6.5-7.6 mm long, dark brown, hispidulous with yellowish ascending hairs. Pappus 1-2.5 mm long; paleae unequal, 9-12, stramineous, fimbrillate.

Endemic on the island of Kauai. Type locality: "In montibus Kauai." Wilkes Expedition (US, type; isotype GH); Waimea Canyon on way to Kokee, Swezey 8009 (Deg, SU); at outlook over Waimea Canyon, Kokee, Bush 8010 (Deg); Waimea drainage basin, west side, Forbes 1699.K (Bish, NY, US); Waimea, Mann and Brigham 535 (Bish, F, GH, NY, US); Waimea, Hillebrand (GH); Kaholuamanu, behind Waimea; Forbes 425.K (Bish, C, F, NY, US); Hitchcock 15297 (US); September 1909, Rock (Bish, NY); Rock 5264 (Bish, GH); Halemanu: February 1909, Rock (NY); Rock 225 (Bish); July 1911, Rock (GH); August 10, 1908, Reed (Bish). Sandwich Islands, Knutsen? (GH, M); without definite locality, 1838-42, Sandwich Islands, Wilkes Expedition (US).

Degener states that this plant occurs also at Milolii, Nualolo, and Olokele, on the barren mountain slopes of leeward Kauai. According

to Fosberg, the species has been multiplying rapidly on the island since the cattle have been removed from the forested areas.

The bare stem of this plant thrusts its leafy crown well above the surrounding grasses and herbaceous vegetation. The large inflorescence commences to bloom in June and the fruit may ripen until September or October. The native name of this species is said to be *iliau.*

FURTHER NOTES ON DUBAUTIA AND RAILLIARDIA

In order to determine the true affinities of *Argyroxiphium,* it has been necessary to take something more than a superficial glance at the genera *Dubautia* and *Railliardia.* Gaudichaud proposed both of the latter genera on successive pages of his account of the flowering plants collected by him on Freycinet's voyage around the world. He proposed two species, *Dubautia plantaginea* and *Railliardia linearis.* A. P. De Candolle added three species to *Railliardia,* and Asa Gray (7b) published five others in an account in which he proposed three sections for the genus and gave a brief account of its phylogenetic connections. Gray stated that *Railliardia* "differs from *Dubautia* chiefly in the slender and truly plumose setae of the pappus, the absence of chaff to the receptacle (which is convex or obtusely conical and pubescent) and in the nearly valvately uniserial involucre, the scales of which connive or lightly cohere into a cylindrical cup." Hillebrand maintained *Dubautia* and *Railliardia* as distinct genera, but in proposing additional species he found that the characters used to distinguish the genera were increasingly fallible. His observations under *Dubautia* are of interest (9, p. 221):

> Its distinguishing characters consist in the free involucral bracts, the paleate receptacle and the broader rays of the pappus, which are only shortly ciliate, not plumose. *Dubautia raillardioides* has, however, a connate involucre, while in *Raillardia Menziesii* and *arborea* the union of the bracts is very loose; in the few-flowered *D. plantaginea* and *raillardioides* the receptacle is mostly naked, while in the large heads of *R. Menziesii* several paleae are always found to be present; and again, the long-ciliate rays of the pappus in *D. plantaginea* approach closely in structure to those of a *Raillardia.*

Does it not seem rather strange that an author would be able to point out so clearly exceptions to every character used to maintain a pair of relatively small genera and still feel able to call the genera distinct? Of his new species *Dubautia raillardioides* Hillebrand says: "A remarkable species which connects closely the present with the following genus [*Railliardia*]. . . . The plant has entirely the

habit of *Dubautia,* the leaves not differing from those of *D. plantaginea*; the pappus also, although somewhat peculiar, bears the character of the genus, but as to the involucre it is altogether raillardioid."

A recent extended account of the two genera by E. E. Sherff (16) throws additional light upon their similarities. His generic diagnoses fail to disclose a single pertinent difference that may be applied to distinguish between them. It is clear that the width and pubescence of the pappus, the chaff on the receptacle and the union of the involucral bracts have lost their value here as diagnostic generic characters because each occurs in both groups. From the material I have seen, and from a study of Sherff's account, I am impressed with the fact that there do not seem to be two natural assemblages involved, distinguished by rather intangible but nevertheless real characters such as aspect, which the systematist frequently finds in nature but has trouble in defining. Rather, *Dubautia* and *Railliardia* appear to form a continuous series or network. This calls for their inclusion within one genus and the line between them seems too indistinct to warrant their retention even as subgenera. In addition to the evident morphological similarity between these groups, their various species cohabit in the montane areas in the Archipelago, from the rain forests to the alpine region above timber line. Sherff gives an admirable systematic account of the species, but evades the question of how the two genera are to be distinguished by failing to raise it.

Last, but not of least importance, is Sherff's announcement that two separate interspecific hybrids are known between species of *Dubautia* and *Railliardia.* These are × *Railliautia fucosa* Sherff (supposedly *Dubautia plantaginea* × *Railliardia scabra* variety *leiophylla*) and × *Railliautia fallax* Sherff (supposedly *Dubautia plantaginea* variety × *Railliardia demissifolia* or *R. thyrsiflora*). Sherff has pointed out several other hybrids within *Dubautia* and *Railliardia.* Their occurrence indicates that the species of this group are still able to intercross to some extent at least, and this intermixture of genic materials accounts for the various recombinations of the morphologic characters found here. Such free intercrossing does not characterize the species of two or more genera but rather the species of a single genus by most present day taxonomic concepts.

It is desirable to go beyond the mere statement of fact that *Dubautia* and *Railliardia* should be regarded as one and the same genus, and make the necessary transfer in order that the new combinations

may be put on record and made available. The International Rules of Botanical Nomenclature (1930) state in Art. 56 that when two groups of the same rank are united, if the names are of the same date, the author who unites the groups has the right of choosing one of them. The choice may be made, therefore, between the names *Dubautia* and *Railliardia,* and for the following reasons I choose *Dubautia*: (1) it is the shorter and an equally euphonious name; (2) it was published with page priority; (3) there has been much confusion regarding the spelling of *Railliardia*; (4) there is a species *Dubautia raillardioides* Hillebrand whose specific name would be inappropriate within *Railliardia.* These advantages outweigh the consideration that a greater number of transfers is required by using *Dubautia.*

Dubautia Gaudichaud, Freycinet Voy., Bot., p. 468, pl. 84, 1830. *Railliardia* Gaudichaud, Freycinet Voy., Bot., p. 469, pl. 83, 1830.

Dubautia latifolia (A. Gray) Keck, new combination (*Railliardia latifolia* A. Gray, Am. Acad., Proc., vol. 5, p. 132, 1861.)

Dubautia scabra (De Candolle) Keck, new combination. (*Railliardia scabra* De Candolle, Prodr., vol. 6, p. 441, 1837. *R. scabra* variety *hispidula* A. Gray, Am. Acad., Proc., vol. 5, p. 133, 1861.)

Dubautia scabra variety **leiophylla** (A. Gray) Keck, new combination. (*Railliardia scabra* variety *leiophylla* A. Gray, Am. Acad., Proc., vol. 5, p. 133, 1861.)

Dubautia scabra variety **Munroi** (Sherff) Keck, new combination. (*Railliardia scabra* variety *Munroi* Sherff, Am. Jour. Botany, vol. 20, p. 619, 1933.)

Dubautia ciliolata (De Candolle) Keck, new combination. (*Railliardia ciliolata* De Candolle, Prodr., vol. 6, p. 441, 1837. *R. ciliolata* variety *laxifolia* A. Gray, Am. Acad. Proc., vol. 5, p. 133, 1861.)

Dubautia ciliolata variety **trinervia** (Hillebrand) Keck, new combination. (*Railliardia ciliolata* variety *trinervia* Hillebrand, Fl. Haw. Isls., p. 226, 1888.)

Dubautia ciliolata variety **juniperoides** (A. Gray) Keck, new combination. (*Railliardia ciliolata* variety *juniperoides* A. Gray, Am. Acad., Proc., vol. 5, p. 133, 1861.)

Dubautia ciliolata variety **laxiflora** (De Candolle) Keck, new combination. (*Railliardia laxiflora* De Candolle, Prodr., vol. 6, p. 441, 1837. *R. Fauriei* Léveillé, Fedde Repert., Spec. Nov. Regn. Veg., vol. 10, p. 122, 1911. *R. ciliolata* variety *laxiflora* Sherff, Am. Jour. Botany, vol. 20, p. 619, 1933.)

Dubautia demissifolia (Sherff) Keck, new combination. (*Railliardia demissifolia* Sherff, Bot. Gaz., vol. 95, p. 78, 1933.)

Dubautia demissifolia variety **verticillata** (Sherff) Keck, new combination. (*Railliardia demissifolia* variety *verticillata* Sherff, Am. Jour. Botany, vol. 20, p. 619, 1933.)

Dubautia molokaiensis (Hillebrand) Keck, new combination. (*Railliardia molokaiensis* Hillebrand, Fl. Haw. Isls., p. 226, 1888.)

Dubautia molokaiensis variety **oppositifolia** (Sherff) Keck, new combination. (*Railliardia molokaiensis* variety *oppositifolia* Sherff, Am. Jour. Botany, vol. 20, p. 619, 1933.)

Dubautia molokaiensis variety **stipitata** (Sherff) Keck, new combination. (*Railliardia molokaiensis* variety *stipitata* Sherff, Am. Jour. Botany, vol. 20, p. 619, 1933.)

Dubautia ternifolia (Sherff) Keck, new combination. (*Railliardia ternifolia* Sherff, Am. Jour. Botany, vol. 20, p. 618, 1933.)

Dubautia thyrsiflora (Sherff) Keck, new combination. (*Railliardia thyrsiflora* Sherff, Am. Jour. Botany, vol. 20, p. 618, 1933.)

Dubautia thyrsiflora variety **cernua** (Sherff) Keck, new combination. (*Railliardia thyrsiflora* variety *cernua* Sherff, Am. Jour. Botany, vol. 20, p. 618, 1933.)

Dubautia lonchophylla (Sherff) Keck, new combination. (*Railliardia lonchophylla* Sherff, Am. Jour. Botany, vol. 20, p. 619, 1933.)

Dubautia coriacea (Sherff) Keck, new combination. (*Railliardia coriacea* Sherff, Bot. Gaz., vol. 95, p. 80, 1933.)

Dubautia linearis (Gaudichaud) Keck, new combination. (*Railliardia linearis* Gaudichaud, in Freycinet Voy., Bot., p. 469, pl. 83, 1830.)

Dubautia linearis variety **opposita** (Sherff) Keck, new combination. (*Railliardia linearis* variety *opposita* Sherff, Am. Jour. Botany, vol. 20, p. 619, 1933.)

Dubautia Hillebrandii (H. Mann) Keck, new combination. (*Railliardia Hillebrandii* H. Mann, Enum. Haw. Pl., no. 238, Am. Acad. Proc., vol. 7, p. 175, 1867.)

Dubautia montana (H. Mann) Keck, new combination. (*Railliardia montana* H. Mann, Enum. Haw. Pl., no. 243, Am. Acad., Proc., vol. 7, p. 176, 1867.)

Dubautia montana variety **longifolia** (Sherff) Keck, new combination. (*Railliardia montana* variety *longifolia* Sherff, Am. Jour. Botany, vol. 20, p. 618, 1933.)

Dubautia montana variety **robustior** (Sherff) Keck, new combination. (*Railliardia montana* variety *robustior* Sherff, Am. Jour. Botany, vol. 20, p. 619, 1933.)

Dubautia reticulata (Sherff) Keck, new combination. (*Railliardia reticulata* Sherff, Bot. Gaz., vol. 95, p. 78, 1933.)

Dubautia struthioloides (A. Gray) Keck, new combination. (*Railliardia struthioloides* A. Gray, Am. Acad., Proc., vol. 5, p. 134, 1861.)

Dubautia Rockii (Sherff) Keck, new combination. (*Railliardia Rockii* Sherff, Bot. Gaz., vol. 95, p. 79, 1933.)

Dubautia Menziesii (A. Gray) Keck, new combination. (*Railliardia Menziesii* A. Gray, Am. Acad., Proc., vol. 5, p. 133, 1861.)

Dubautia Menziesii variety **angustifolia** (Sherff) Keck, new combination. (*Railliardia Menziesii* variety *angustifolia* Sherff, Am. Jour. Botany, vol. 20, p. 618, 1933.)

Dubautia arborea (A. Gray) Keck, new combination. (*Railliardia arborea* A. Gray, Am. Acad., Proc., vol. 5, p. 134, 1861.)

Dubautia platyphylla (A. Gray) Keck, new combination. (*Railliardia platyphylla* A. Gray, Am. Acad., Proc., vol. 5, p. 134, 1861.)

Dubautia platyphylla variety **leptophylla** (Sherff) Keck, new combination. (*Railliardia platyphylla* variety *leptophylla* Sherff, Am. Jour. Botany, vol. 20, p. 619, 1933.)

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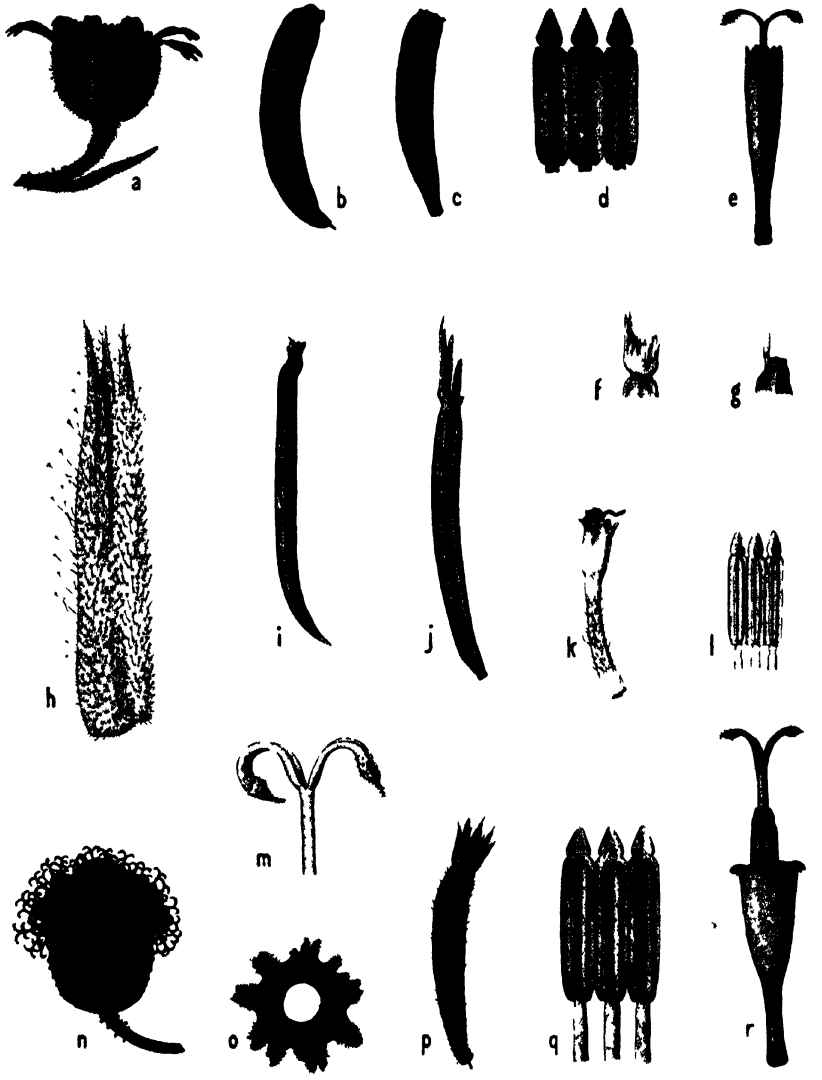

PLATE 1.—*Argyroxiphium sandwicense* De Candolle (*a-g*); *a*, head, × 1; *b-c*, ray- and disk-akene, × 4; *d*, anthers, × 8; *e*, disk-flower, × 4; *f-g*, disk- and ray-pappus, × 4; *a-e*, Degener No. 3527; *f-g*, type in De Candolle Herbarium. *Argyroxiphium virescens* Hillebrand (*h-l*): *h*, involucral bract adherent to bracts of receptacle, × 4; *i-j*, ray- and disk-akene, × 4; *k*, disk-flower, × 4; *l*, anthers, × 8; *h-l*, Degener No. 3528. *Argyroxiphium gymnoxiphium* (A. Gray) Keck (*m-r*): *m*, style-branches, × 8; *n*, head, × 1; *o*, involucre as seen from above, × 1; *p*, akene, × 4; *q*, anthers, × 8; *r*, floret, × 4; *m-r*, Swezey No. 8009. Drawn by Link Malmquist.

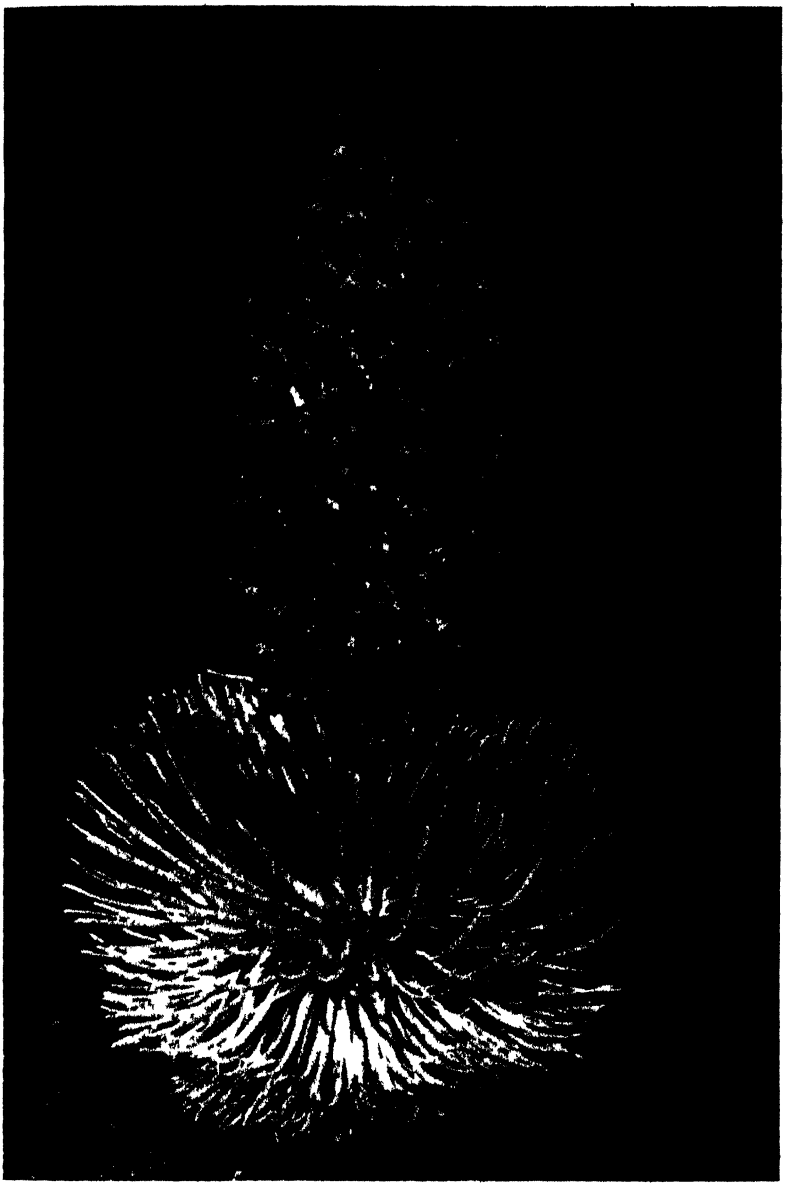

PLATE 2.—*Argyroxiphium sandwicense* De Candolle. Crater of Haleakala, Maui. (Photograph from B. P. Bishop Museum.)

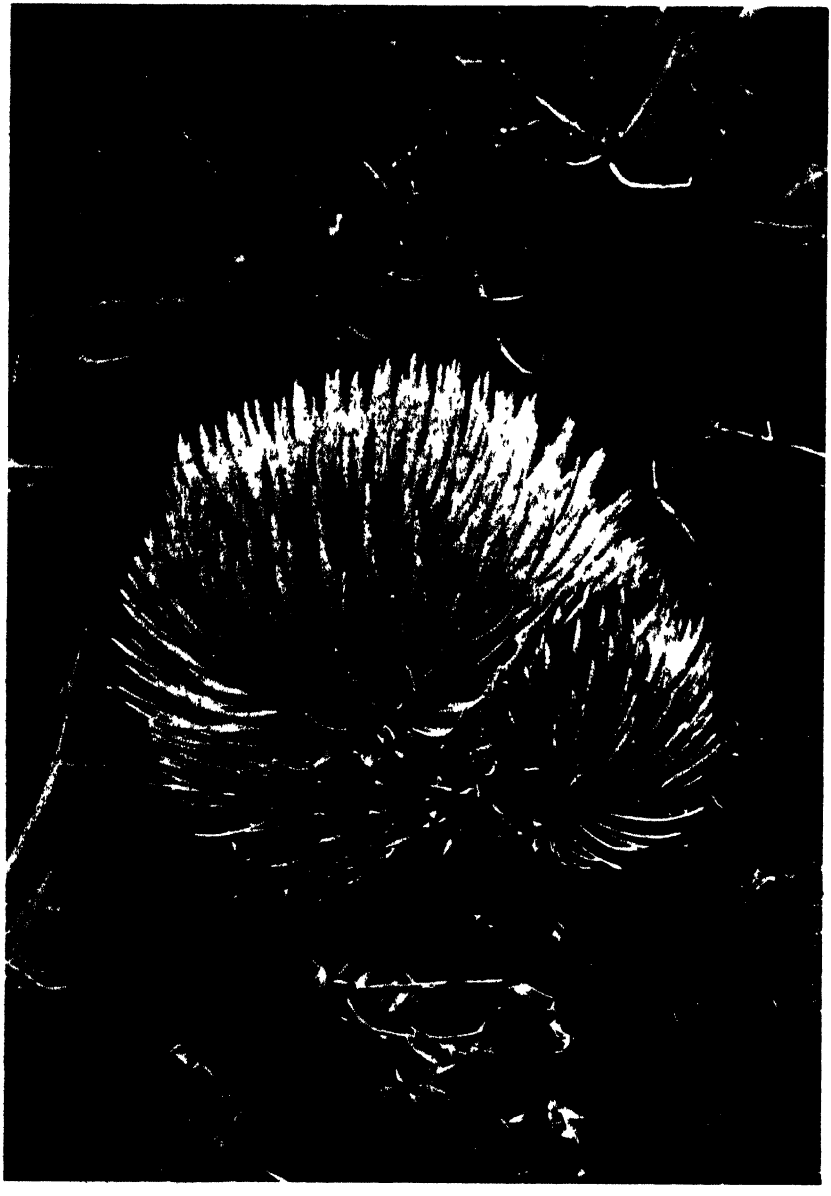

PLATE 3.—*Argyroxiphium sandwicense* De Candolle, young plant with secondary rosette, crater of Haleakala, Maui. (Photograph by R. J. Baker, Honolulu.)

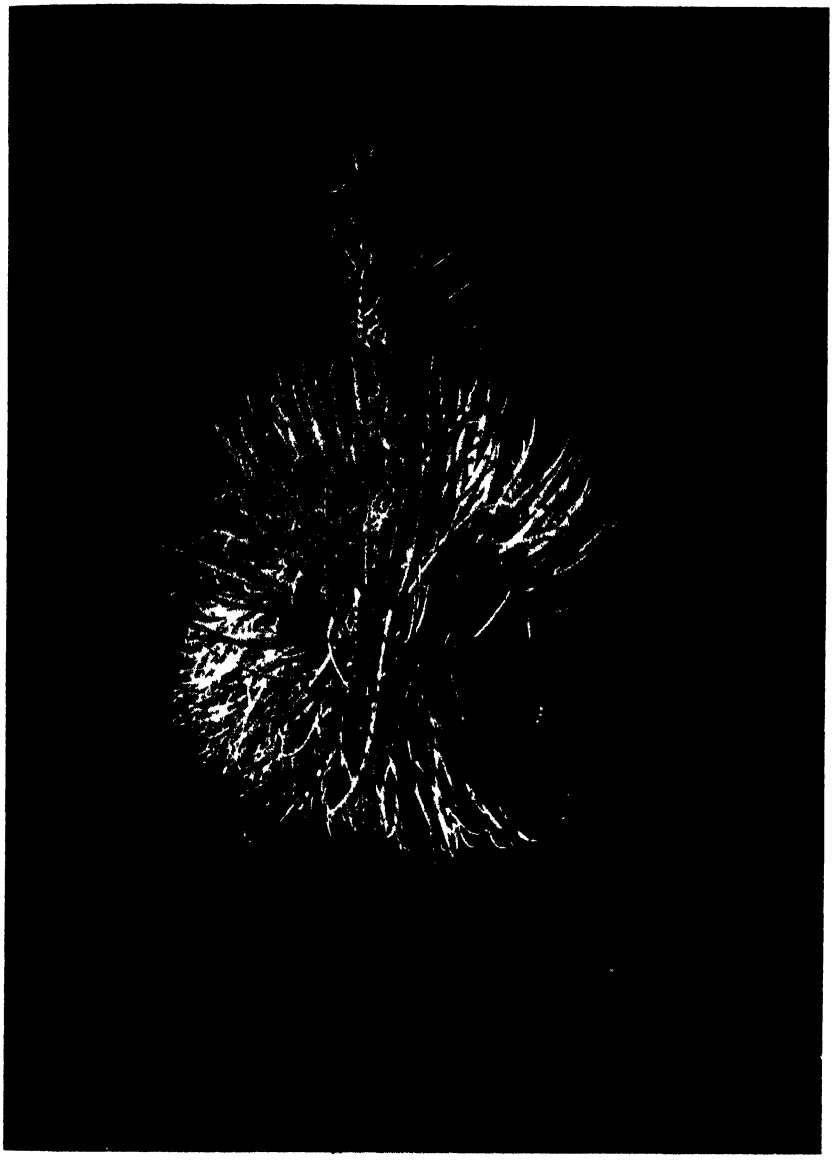

PLATE 4.—*Argyroxiphium sandwicense* De Candolle, showing remains of the inflorescence. (Photograph by R. J. Baker, Honolulu.)

PLATE 5—*Argyroxiphium sandwicense* De Candolle, 1/2 2 natural size

PLATE 6.—*Argyroxiphium virescens* Hillebrand, 1/2.4 natural size.

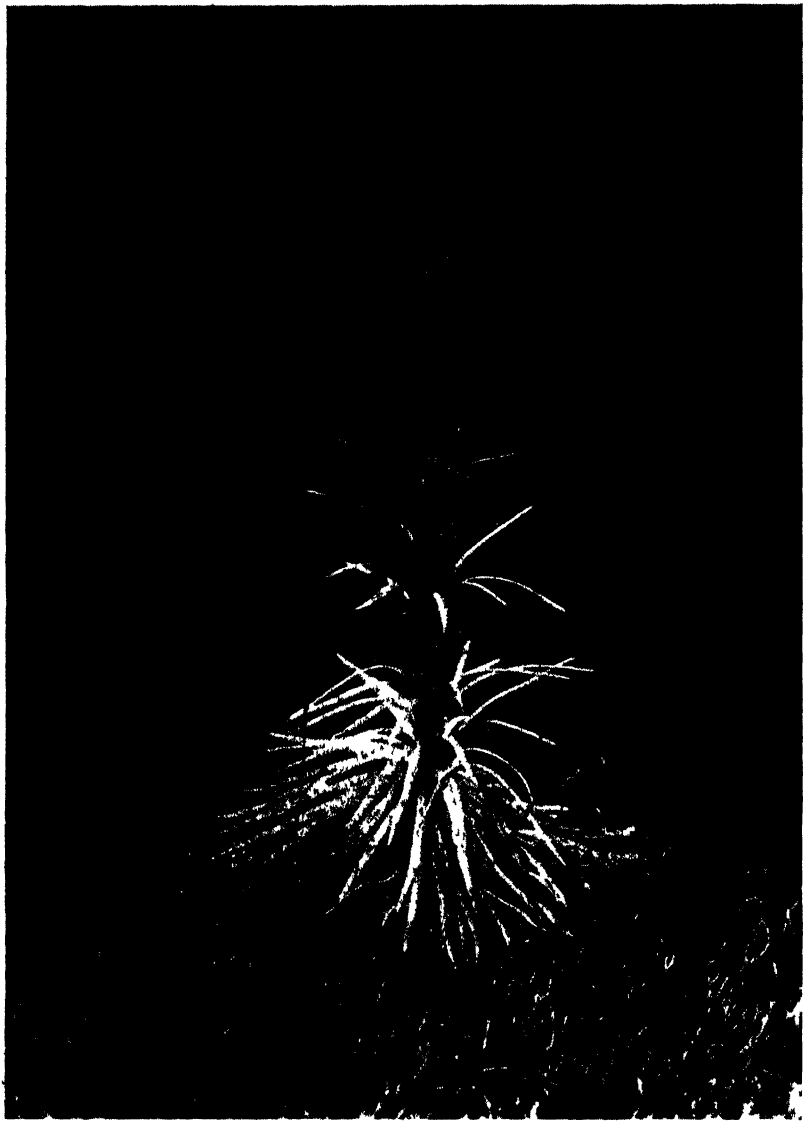

PLATE 7.—*Argyroxiphium caliginì* Forbes. (Photograph from B. P. Bishop Museum.)

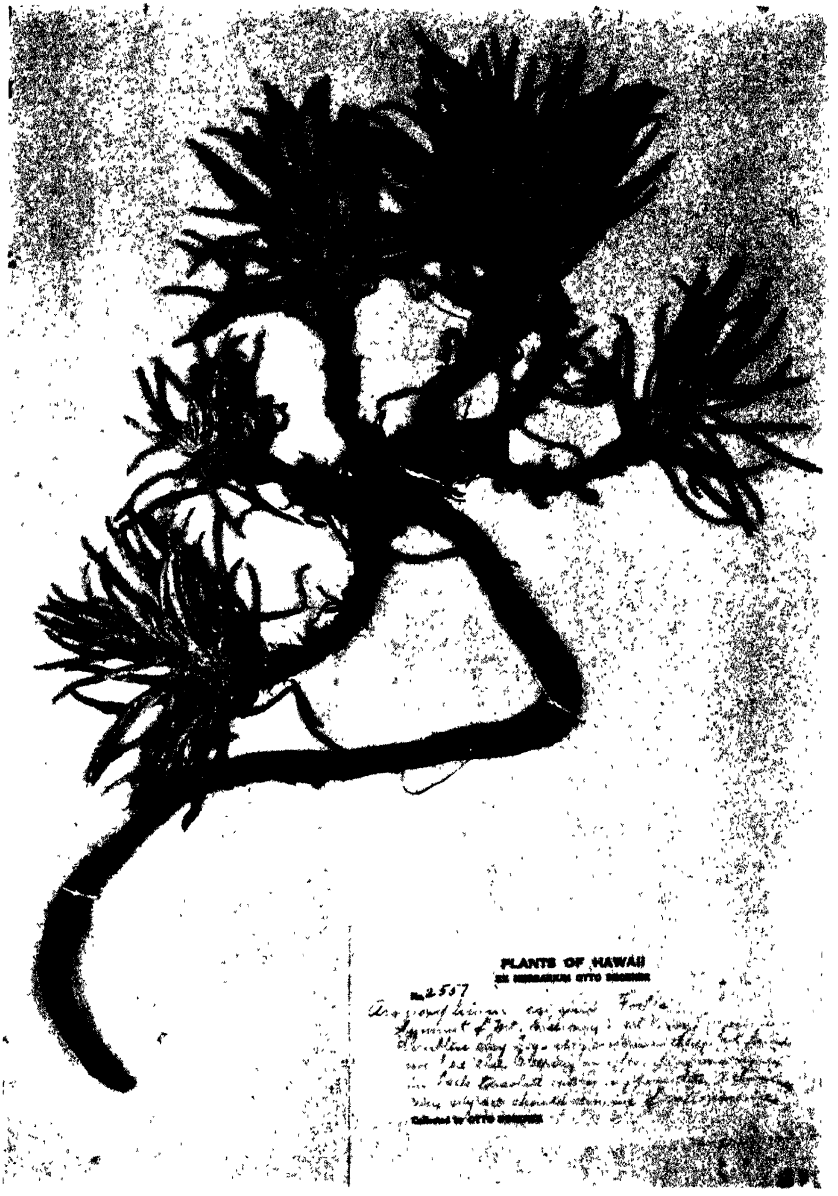

PLATE 8.—*Argyroxiphium caligini* Forbes, young plant with immature rosettes, 1/2 natural size.

PLATE 9.— × *Argyroxiphium Kai* (*A. caligini* × *Grayanum*), 1/2.4 natural size.

CONTRIBUTION TO THE MOSSES OF FIJI

By

EDWIN B. BARTRAM

BERNICE P. BISHOP MUSEUM

OCCASIONAL PAPERS

VOLUME XI, NUMBER 20

HONOLULU, HAWAII

PUBLISHED BY THE MUSEUM

March 20, 1936

CONTRIBUTION TO THE MOSSES OF FIJI

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INTRODUCTION

The strategic position of the Fiji Islands in connection with the geographical distribution of flowering plants applies equally well to the mosses. A strong thrust of such typical southeastern Malaysian species as *Arthrocormus Schimperi, Leucobryum sanctum, Syrrhopodon Mulleri, Hypnodendron arborescens, Piloecium pseudo-rufescens, Meteorium Miquelianum, Meiothecium hamatum, Rhaphidostichium luxurians,* and *Microctenidium Leveilleanum* emphasizes this tendency and indicates a marked migratory current through the region.

Dixon[1] remarks that the total of 205 species included in "The Mosses of Fiji" represents probably half of the ultimate number. This estimate may be slightly optimistic but further explorations, especially in the higher regions of central Viti Levu, will surely expand the list to a generous extent. With the additional records of 19 established species, and 12 new species comprised in the following detailed list, the total of known species is increased to approximately 235.

The mosses collected by Dr. A. C. Smith in Fiji between October 1933 and July 1934 in cooperation with Bernice P. Bishop Museum are represented by some 200 numbers many of which are in sufficient quantity for wide distribution. These form the nucleus of my report. I have also included a few records based on small specimens that were separated, for the most part, from J. W. Gillespie's plants in the herbarium of Bernice P. Bishop Museum by Miss Marie C. Neal.

Smith[2] has written a narrative of his activities in Fiji, outlining in detail the topographical and floristic features of the country. Fortunately, from the viewpoint of a bryologist, his activities were centered on a number of the outlying islands previously unvisited by a botanist. As these areas are difficult of access the records are likely to remain unique. They represent an important addition to our knowledge of the Fiji mosses.

[1] Dixon, H. N., The Mosses of Fiji: Linnean Soc. New South Wales, Proc., vol. 55, pt. 3, pp. 261-302, 1930.

[2] Smith, A. C., Plant Collecting in Fiji: N. Y. Bot. Garden, Jour., vol. 35, pp. 261-280, 1934.

The type collections of the new species are represented in the herbarium of Bernice P. Bishop Museum and in the herbarium of the author.

SPHAGNACEAE

Sphagnum Seemanii C. Müller.

Taveuni: borders of lake east of Somosomo, elevation 700-900 meters, common in swamp, Smith no. 867.

FISSIDENTACEAE

Fissidens mangarevensis Montagne.

Vanua Levu: Thakaundrove, southern slope of Valanga Range, elevation 100 meters, on decayed wood, dense forest, Smith no. 369c.

Fissidens lautokensis Dixon.

Vanua Levu: Thakaundrove, Mount Mbatini, elevation 700-1,030 meters, on tree trunks, crest of range, dense thickets, Smith no. 642b.

DICRANACEAE

Dicranoloma Braunii (C. Müller) Paris.

Viti Levu: Tholo North Province, near summit of Mt. Victoria, elevation 1,300 meters, on branches and leaves of *Ternstroemia vitiensis,* Gillespie no. 4114.

The plants under this number are few and sterile. Supplementary collections in better condition are needed to definitely establish its identity. As this is the only *Dicranoloma* so far reported from Fiji, the record is a notable one. The stems lack the filamentose propagula that are characteristic of *D. Braunii* and the leaves end in long setaceous points. It may prove to be a form of *D. Blumei* (Nees) but is certainly not typical.

Leucoloma tenuifolium Mitten.

Vanua Levu: Thakaundrove, Mount Ndikeva, elevation 500 meters, on tree trunks, dense forest, eastern slope, Smith no. 1903a; Natewa Peninsula, Uluingala, elevation 600-820 meters, dense forest, on tree trunks, Smith no. 1983a. Taveuni: borders of lake east of Somosomo, elevation 700-900 meters, Smith no. 882c; western slope between Somosomo and Wairiki, elevation 600 meters, Smith no. 756a.

Braunfelsia scariosa (Wilson) Paris.

Viti Levu: summit of Voma mountain, elevation 1,000 meters, on fern (*Dryopteris viscosa*), Gillespie no. 2746.

New to Fiji. Further collections are necessary to definitely determine this species now based on a single sterile collection.

LEUCOBRYACEAE

Leucobryum pungens C. Müller.

Viti Levu: on fern (*Blechnum vulcanicum*), Gillespie no. 2715.

Leucobryum Teysmannianum Bryologia javanica.

Vanua Levu: Thakaundrove, Mount Mbatini, elevation 700-1,030 meters, on humus, crest of range, dense forest, Smith no. 648a; Yanawai River region, Mount Kasi, elevation 300-430 meters, Smith no. 1811a. Vanua Mbalavu: northern limestone section, elevation 0-200 meters, forest, forming dense mats on humus, Smith no. 1464. Koro: on caudex of tree ferns, dense forest, main ridge, elevation 300-500 meters, Smith no. 1051a.

Leucobryum pentastichum Bryologia javanica.

Kambara: limestone formation, elevation 0-100 meters, on palm trunks, clearing, Smith no. 1249. Kandavu: hills above Namalata and Ngaloa Bays, elevation 200-400 meters, on decayed logs, dense forest, Smith no. 147a.

Leucobryum sanctum Hampe.

Viti Levu: with fern (*Lindsaya adiantoides*), Gillespie no. 2718.

Leucophanes candidum (Hornschuch) Lindberg variety **densifolium** (Mitten) Dixon.

Vanua Levu: Thakaundrove, Natewa Peninsula, hills south of Natewa, elevation 400-600 meters, forming dense mats on decayed wood, dense forest, Smith no. 1958.

Arthrocormus Schimperi Dozy and Molkenboer.

Koro: eastern slope of main ridge, elevation 300-500 meters, on tree trunk, forest, Smith no. 975; on caudex of tree ferns, dense forest, main ridge, elevation 300-500 meters, Smith no. 1051c.

New to Fiji.

Exodictyon dentatum (Mitten) Cardot.

Viti Levu: Thakaundrove, Mount Mbatini, elevation 700-1,030 meters, on decayed wood, crest of range, dense thickets, Smith no.

638. Koro: on caudex of tree ferns, dense forest, main ridge, elevation 300-500 meters, Smith no. 1051b.

CALYMPERACEAE

Syrrhopodon Banksii C. Müller.

Viti Levu: near Suva, C. H. Edmondson.

New to Fiji.

Syrrhopodon Graeffeanus C. Müller.

Vanua Levu: Thakaundrove, Mount Mariko, on tree trunks, dense forest, Smith no. 442a. Taveuni: borders of lake east of Somosomo, elevation 700-900 meters, on trees, dense forest, Smith no. 882b; with fern (*Hymenophyllum australe*), Gillespie no. 5125. Viti Levu: on fern (*Blechnum vulcanicum*) Gillespie no. 2715a; with fern (*Lindsaya adiantoides*), Gillespie no. 2366.

The lamina cells in these collections are constantly papillose. The leaves average shorter than in *S. tristichus,* the apex is uniformly more sharply pointed, and the costa distantly spinose on the back. If these distinctions are maintained the species should be perfectly valid.

Syrrhopodon (Tristichi) Smithii, new species (fig. 1).

Gracilescens, caespitosus, caespitibus densis, supra pallide viridibus intus rubescens. Caulis ad 2 cm altus, simplex, basi parce radiculosus. Folia conferta, e basi albida, erecta, erecto-patentia, sicca vix mutata, ad 6 mm longa, limbata, limbo angusto, hyalino, fere ad apicem producto; margines laminae remote et minute spinuloso-denticulati, inferne integri; costa e media basi ad apicem dorso scabra; cellulae superiores rotundatae, dense papillosae, obscurae, cancellina supra rotundata. Caetera ignota.

Vanua Levu: Thakaundrove, Mount Ndikeva, elevation 900 meters, on decayed wood, crest thickets, eastern buttress; Smith no. 1880 (type).

Distinguished at once from both *S. Graeffeanus* C. Müller and *S. tristichus* Nees by the crowded, erect-spreading leaves, the larger, obscure lamina cells coarsely papillose with multifid papillae, the finely toothed leaf margins and the costa scabrous on the back to below the top of the leaf base.

I feel it a privilege to associate the name of Dr. A. C. Smith with this very distinct species.

Syrrhopodon mamillatus C. Müller.

Vanua Levu: Thakaundrove, Natewa Peninsula, hills west of

Mbutha Bay, elevation 150-350 meters, on decayed wood, forest, Smith no. 821; Mount Ndikeva, elevation 800 meters, on humus, dense forest, eastern buttress, Smith no. 1872; hills between Vatukawa and Wainingio Rivers, Ndrekeniwai Valley, elevation 200-500 meters, on decayed wood, Smith no. 585; Mbua, southern portion of Seatovo Range, elevation 100-350 meters, on humus, forest, Smith no. 1535; Mbua, southern slope of Mount Seatura, elevation 400 meters, on decayed wood, dense forest, Smith no. 1614. Taveuni: western slope between Somosomo and Wairiki, elevation 700-900 meters, on decayed wood, forest, Smith no. 760, 731. Kandavu: hills above Namalata and Ngaloa Bays, elevation 200-400 meters, on decayed logs, dense forest, Smith no. 148.

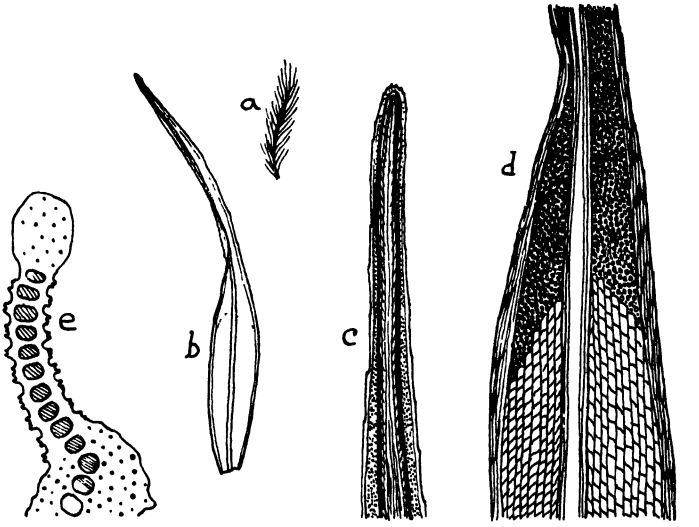

FIGURE 1.—*Syrrhopodon Smithii* Bartram: *a*, plant, × ¾; *b*, leaf, × 8; *c*, apex of leaf, × 60; *d*, upper part of leaf base, × 60; *e*, part of cross section of leaf, × 300.

Syrrhopodon Mulleri (Dozy and Molkenboer) Bryologia javanica.

Koro: eastern slope of main ridge, elevation 300-500 meters, on tree trunk, dense forest, Smith no. 990.

This collection deviates from the usual form in the longer setae, more uniformly acute leaf apices, and papillose lamina cells, but I doubt if any of these characters are of more than minor importance. Authentic specimens from other regions frequently have the lamina

cells papillose and leaves from the same plant often show considerable variation in the shape of the apex. New to Fiji.

Syrrhopodon croceus Mitten.

Viti Levu: Six miles from Suva, C. H. Edmondson.

Thyridium luteum Mitten.

Vanua Levu: Thakaundrove, Mount Ndikeva, on tree trunk, dense forest, eastern buttress, elevation 800 meters, Smith nos. 1864, 1903, Mbua, southern slope of Mount Seatura, elevation 600 meters, on tree trunk, Smith no. 1625. Koro: eastern slope of main ridge, elevation 300-500 meters, on tree trunks, forest, Smith no. 980.

Calymperes tahitense (Sullivant) Mitten.

Vanua Levu: Thakaundrove, southern slope of Valanga Range, elevation 200-400 meters, Smith no. 369d.

Calymperes lorifolium Mitten.

Vanua Levu: Thakaundrove, Mount Mariko, elevation 600-866 meters, on decayed bark, Smith no. 459d; Yanawai River region, Mount Kasi, elevation 300-430 meters, on decayed wood, dense forest, Smith no. 1814a.

Calymperes (Eucalymperes) subulatum, new species (fig. 2).

Caules brevissimi, gregarii. Folia erecto-patentia, sicca parce contorta, e basi breve, longe ligulata ad 9 mm longa et 0.5 mm lata, limbata, apice subulato-acuminato; margines basilares minute denticulati, superne limbum angustum, indistinctum, perincrassatum, minute denticulatum, apice remote dentato circumducta; costa pervalida, dorso minute papillosa, in subulam evanida; cellulae superiores minutae, rotundatae, mamillosae, vix incrassatae, cancellina supra rotundata, bene definita. Caetera ignota.

Vanua Levu: Thakaundrove, Mount Ndikeva, elevation 400 meters, tree trunks, dense forest, eastern slope, Smith no. 1913a (type).

With the habit and appearance of *C. lorifolium* Mitten this species is appreciably smaller. It is apparently quite distinct in the long proboscoid leaf apex and especially in the minute, opaque, mamillose cells of the lamina with firm but not incrassate walls.

POTTIACEAE

Hyophila Micholitzii Brotherus.

Fulanga: limestone formation, elevation 0-80 meters, on hard soil, clearing, Smith no. 1149.

BRYACEAE

Rhodobryum Graeffeanum (C. Müller) Paris.

Vanua Levu: Thakaundrove, Natewa Peninsula, hills south of Natewa, elevation 400-600 meters, forming dense mats on wet rocks, dense forest, Smith no. 1963.

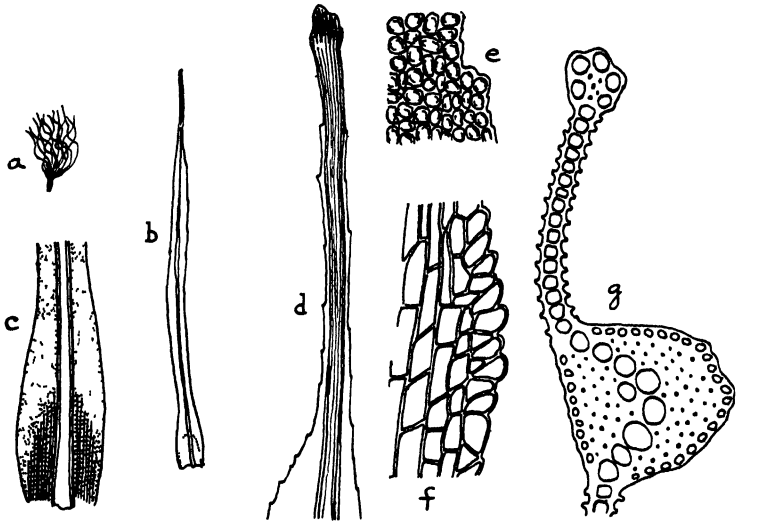

FIGURE 2.—*Calymperes subulatum* Bartram: *a*, plant, × ¾; *b*, leaf, × 6; *c*, leaf base, × 22.5; *d*, apex of leaf, × 60; *e*, upper leaf cells and margin, × 300; *f*, marginal cells of leaf base, × 300; *g*, part of cross section of leaf, × 300.

CALOMNIACEAE

Calomnion Dixoni, new species (fig. 3).

Dioicum? Gracile, laxe caespitosum, sordide viride intus fuscum, haud nitidum, Caulis simplex vel parce ramosus, nigrescentibus, circa 1.5 mm latus. Folia superne sat conferta, ovata, acuta, 1-1.4 mm longa, patentia, sicca leniter contorta; costa valida, fusca, percurrens vel infra apicem evanida; marginibus planis, fere ad basin irregulariter denticulatis, cellulae superiores rotundatae, incrassatae, laevissimae, 10-12 μ, basilares lineares, parietibus incrassatis, sinuosis, infimae fuscae. Caetera ignota.

Viti Levu: Tholo North Province, near summit of Mt. Victoria, elevation 1,300 meters, on branches and leaves of *Ternstroemia vitiensis,* Gillespie no. 4114 (type).

This species is distinct from *C. denticulatum* Mitten, of Samoa, in the more crowded upper leaves, the broader, shorter leaf apices,

the rounded and more incrassate upper leaf cells, and particularly in the well differentiated linear basal cells with porose lateral walls.

I have named this species after Mr. H. N. Dixon, who has contributed a great deal to the study of the mosses of the Antipodes.

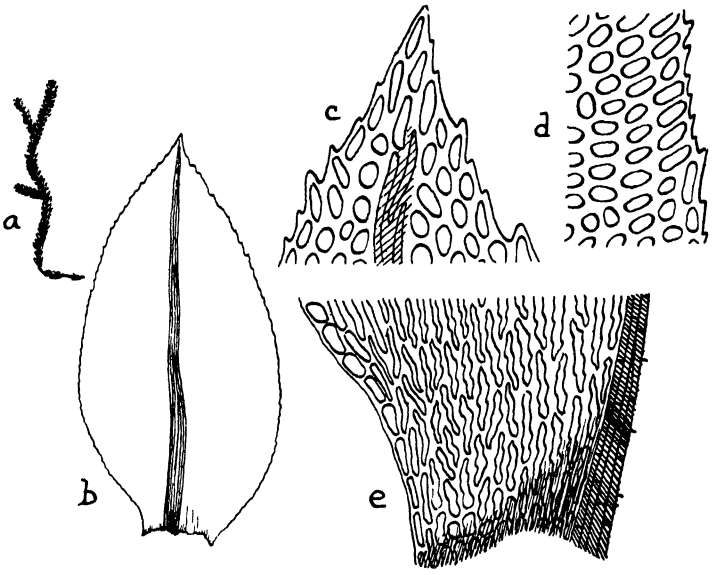

FIGURE 3—*Calomnion Dixoni* Bartram: *a*, plant, × ¾; *b*, leaf, × 45; *c*, apex of leaf, × 300; *d*, upper leaf cells and margin, × 300; *e*, one side of leaf base, × 300.

RHIZOGONIACEAE

Rhizogonium spiniforme (Hedwig) Bruch form **samoana** Mitten.

Specimens from Vanua Levu, Kandavu, Koro and Moala indicate that this well-known species is distributed throughout the group.

HYPNODENDRACEAE

Hypnodendron arborescens Mitten.

Vanua Levu: Thakaundrove, Mount Mbatini, elevation 700-1,030 meters, on tree trunks, crest of range, dense thickets, Smith no. 642. Taveuni: borders of lake east of Somosomo, elevation 700-900 meters, on trees, dense forest, Smith no. 882. Kandavu: Mount Mbuke Levu, elevation 750-840 meters, epiphyte, summit, dense forest, Smith no. 294.

Mniodendron tahiticum Bescherelle.

Vanua Levu: Mount Ndikeva, elevation 800 meters, on humus, crest thickets, eastern buttress, Smith no. 1887a (a small form).

A small, compact form that may be attributed to the exposed habitat. The structural details are precisely those of the typical form from Tahiti.

BARTRAMIACEAE

Philonotis viridifolia, new species (fig. 4).

Robustiuscula, caespitosa, caespitibus densiusculis, depressis, mollibus, viridibus, intus fuscis. Caulis elongatus, ad 7 cm longus, simplex vel parce ramosus, inferne radiculosus. Folia secunda, ovato-lanceolata, acuminata, 2-2.3 mm longa; marginibus fere ad apicem anguste recurvis, denticulatis; costa valida, breviter excurrens, dorso superne scabra; cellulae superiores oblongae, circa 10 μ latae, chlorophyllosae, in angulis superioribus papillosae, basilares laxae, pellucidae, ad 20-22 μ latae, parietibus tenuissimus. Caetera ignota.

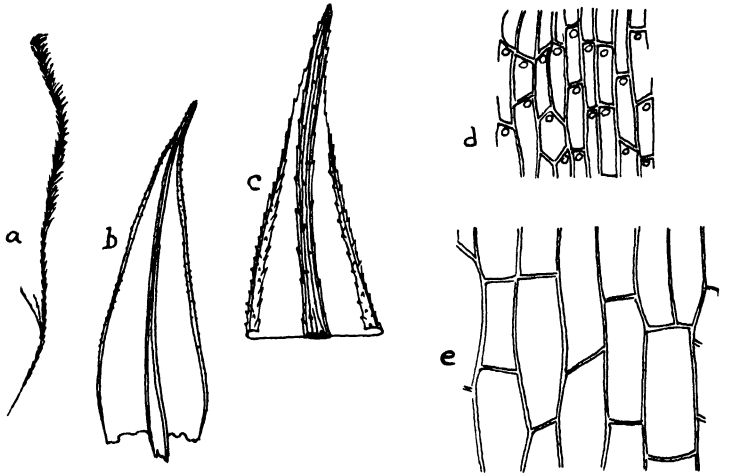

FIGURE 4.—*Philonotis viridifolia* Bartram: *a*, plant, × ¾; *b*, leaf, × 22.5; *c*, apex of leaf, × 60; *d*, upper leaf cells, × 300; *e*, basal leaf cells, × 300.

Vanua Levu: Mbua, upper Ndama River valley, elevation 100-300 meters, on rocks in streams, Smith no. 1695 (type).

Suggestive of a very robust form of *P. laxissima* (C. Müller) in general appearance but distinct in the broader, more sharply acuminate leaves and the papillose cells.

SPIRIDENTACEAE

Spiridens aristifolius Mitten.

Vanua Levu: Natewa Peninsula, Uluingala, elevation 600-820 meters, densely covering trees, Smith no. 1991. Taveuni: borders of lake east of Somosomo, elevation 700-900 meters, on trees, dense forest, Smith no. 924.

Spiridens flagellosus Schimper.

Vanua Levu: Thakaundrove, Mount Mariko, elevation 600-866 meters, epiphyte, dense forest, Smith no. 443.

ORTHOTRICHACEAE

Macromitrium tongense Sullivant.

Vanua Levu: Thakaundrove, hills between Vatukawa and Wainingio Rivers, Ndrekeniwai valley, forest, on stony soil, Smith no. 594. Vanua Mbalavu: southern limestone section, elevation 0-100 meters, on tree trunks, forest, Malatta, Smith no. 1443. Moala: on tree trunk, forest near Naroi, elevation 200 meters, Smith no. 1308.

Macromitrium Beecheyanum Mitten.

Vanua Levu: Thakaundrove, Mount Ndikeva, on tree trunks, crest thickets, eastern buttress, Smith no. 1881.

Macromitrium incurvifolium Schwaegrichen.

Vanua Levu: Natewa Peninsula, hills south of Natewa, elevation 400-600 meters, on trees, dense forest, Smith no. 1966, Taveuni: borders of lake east of Somosomo, elevation 700-900 meters, on decayed wood, dense forest, Smith no. 926.

RHACOPILACEAE

Rhacopilum spectabile Reinwardt.

Taveuni: borders of lake east of Somosomo, elevation 700-900 meters, on humus, dense forest, Smith no. 849.

CYRTOPODACEAE

Bescherellea cryphaeoides (C. Müller) Fleischer.

Vanua Levu: Thakaundrove, Natewa Peninsula, Uluingala, elevation 600-800 meters, on tree trunks, dense forest, Smith no. 1983.

PTYCHOMNIACEAE

Ptychomnion aciculare (Bridel) Mitten.

Taveuni: summit of Uluingalau, elevation 1,000-1,220 meters, on humus, dense forest, Smith no. 911.

New to Fiji. The appearance of this well-known species in Fiji is interesting but not unexpected. It simply pieces out the northwestern fringe of its distribution.

MYURIACEAE

Myurium purpuratum (Mitten) Brotherus.

Viti Levu: with fern (*Lindsaya adiantoides*), Gillespie no. 2718.

New to Fiji. The limited distribution of this species makes its presence in Fiji noteworthy.

Piloecium pseudo-rufescens (Hampe) C. Müller.

Vanua Levu: Mbua, Lower Wainunu River valley, elevation 0-200 meters, on tree trunks, edge of forest, Smith no. 1751.

PTEROBRYACEAE

Euptychium setigerum (Sullivant) Brotherus.

Vanua Levu: Thakaundrove, Mount Ndikeva, elevation 800 meters, on tree trunks, crest thickets, eastern buttress, Smith no. 1885; Natewa Peninsula, Uluingala, elevation 600-820 meters, covering trunks and branches, Smith no. 1989; Yanawai River region, Mount Kasi, elevation 300-430 meters, on tree trunks, dense forest, Smith no. 1810; Mount Mbatini, elevation 700-1,030 meters, on tree trunks, crest of range, dense thickets, Smith no. 650.

Symphysodon vitianus (Sullivant) Brotherus.

Taveuni: borders of lake east of Somosomo, elevation 700-900 meters, Smith no. 926a.

Symphysodontella cylindracea (Montagne) Fleischer.

Vanua Levu: Thakaundrove, Mount Ndikeva, elevation 500 meters, on tree trunks, dense forest, eastern slope, Smith 1903b.

METEORIACEAE

Papillaria crocea (Hampe) Jaeger.

Viti Levu: Tholo North Province, Nandarivatu, 2 miles along Nandrau trail, on *Memecylon vitiense* A. Gray, Gillespie no. 4217.

Papillaria intricata (Mitten) Jaeger.

Viti Levu: Namosi Province, Naitarandamu Mountain, elevation 1,100 meters, on *Cyrtandra montana,* Gillespie no. 3144a.

Meteorium Miquelianum (C. Müller) Fleischer.

Viti Levu: Tomanivi (Mount Victoria), elevation 1,200 meters, on *Freycinetia caudata,* Gillespie no. 4092.

Aerobryopsis vitiana (Sullivant) Fleischer.

Taveuni: western slope between Somosomo and Wairiki, on tree trunks, forest, Smith 756b.

Floribundaria aeruginosa (Mitten) Fleischer.

Vanua Levu: Thakaundrove, Mount Mariko, elevation 600-866 meters, on decayed wood, Smith no. 474a.

Floribundaria floribunda (Dozy and Molkenboer) Fleischer.

Viti Levu: Namosi Province, Naitarandamu Mountain, Gillespie nos. 3102, 3249, 3144.

PHYLLOGONIACEAE

Orthorrhynchium cylindricum (Lindberg) Brotherus.

Viti Levu: Namosi Province, slopes of Voma Mountain, elevation 600 meters, on *Litsea magnifolia,* Gillespie no. 2921.

Eucatagonium gracile (Bescherelle) Brotherus.

Kambara: limestone formation, elevation 0-100 meters, on roots of large trees, forest, Smith no. 1271.

New to Fiji. I have not seen the type of *Acrocladium gracile* Bescherelle from Tahiti but the Fiji plants seem to belong here without much question. Dixon has remarked that Bescherelle's comparison with *E. politum*, of New Zealand, is misleading in some particulars. My New Zealand specimens of *E. politum* are quite uniformly more slender than the Fiji plants but the leaf apex and areolation are quite distinctive. In *E. gracile* the leaf apex is bluntly short acuminate in bold contrast with the slender, apiculate point of *E. politum.* The leaf cells are uniformly shorter and more opaque, minutely papillose by the projecting ends and the margins minutely denticulate.

NECKERACEAE

Neckeropsis lepineana (Montagne) Fleischer.

Vanua Levu: Thakaundrove, Natewa Peninsula, hills south of Natewa, elevation 400-600 meters, in masses on wet rock, dense forest, Smith no. 1957.

Himantocladium implanum (Mitten) Fleischer.

Koro: eastern slope of main ridge, on moist stones in stream, Smith no. 987a. Vanua Levu: Thakaundrove, southern slope of Valanga Range, elevation 200-400 meters, on tree trunks, dense forest. Smith no. 394. Moala: on rocks and large roots, forest near Maloku, elevation 300 meters, Smith no. 1340.

Homaliodendron flabellatum (Dickson) Fleischer.

Vanua Levu: Thakaundrove, Mount Mbatini, elevation 700-1,030 meters, on tree trunks, crest of range, dense thickets, Smith no. 642d.

Pinnatella Kuhliana (Bryologia javanica) Fleischer.

Taveuni: borders of lake east of Somosomo, elevation 700-900 meters, on humus, dense forest, Smith no. 849a.

Thamnium subulatifolium Dixon.

Koro: eastern slope of main ridge, on moist stones in stream, dense forest, Smith no. 987.

HOOKERIACEAE

Distichophyllum vitianum (Sullivant) Bescherelle.

Vanua Levu: Thakaundrove, southwestern slope of Mount Mbatini, elevation 300-700 meters, on decayed wood, Smith no. 633; southern slope of Korotini Range below Navitho Pass, elevation 300-650 meters, on wet rocks, Smith no. 511. Kandavu: Mount Mbuke Levu, elevation 750-840 meters, on decayed wood, summit, Smith no. 274a.

Distichophyllum (Mniadelphus) lingulatum, new species (fig. 5).

Dioicum? Sat robustum. Caulis ad 3 cm altus, simplex, basi fusco-tomentosus, circa 5 mm latus. Folia conferta, arcte complanata, sicca leniter undulata, haud torquata, spathulato-lingulata, apice rotundato vel minute apiculato, 3.5 mm longa et 1.8 mm lata; margines plani, superne crenulati; costa debilis, longe infra apicem soluta; limbus folii angustissimis, 1-2 seriebus cellularum compositis; cellulae superiores rotundato-hexagonae, mediane circa 25 μ latae,

versus margines multo minores, parietibus firmis, basilares rectangulares. Folia perichaetialia multo minora, acuta, cellulae omnes laxae, rhomboideae; seta hispida, ad 7 mm longa; theca parva, inclinata, vix 1 mm longa; calyptra basi longe fimbriata, superne dense hispida.

Vanua Levu: Thakaundrove, southwestern slope of Mount Mbatini, elevation 300-700 meters, on decayed wood, dense forest, Smith no. 633a. Koro: eastern slope of main ridge, on caudex of tree fern, elevation 300-500 meters, Smith no. 973 (type).

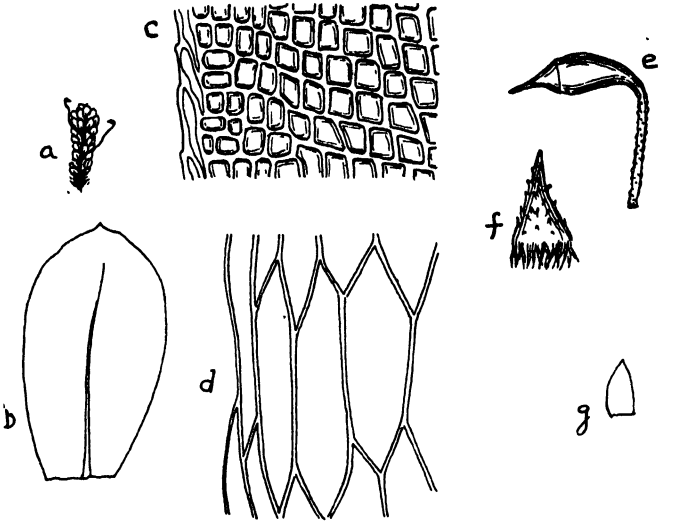

FIGURE 5.—*Distichophyllum lingulatum* Bartram: *a*, plant, × ¾; *b*, leaf, × 12; *c*, upper leaf cells and margin, × 300; *d*, basal leaf cells and margin, × 300; *e*, capsule, × 12; *f*, calyptra, × 12; *g*, perichaetial leaf, × 12.

Sharply distinct from *D. vitianum* (Sullivant) in the minute apical and marginal cells of the upper leaf blade. It appears to be near *D. mascarenicum* Bescherelle, from the description, but differs widely in the dioicous inflorescence, the narrower leaf border, longer setae and crowded leaves with rounded or apiculate apices.

Cyclodictyon Blumeanum (Montagne) Fleischer.

Vanua Levu: Thakaundrove, Mount Mariko, elevation 600-866 meters, Smith nos. 467, 475.

Callicostella papillata (Montagne) Mitten.

Vanua Levu: Thakaundrove, Natewa Peninsula, hills south of

Natewa, elevation 400-600 meters, on decayed wood, dense forest, Smith no. 1973. Koro: eastern slope of main ridge, elevation 300-500 meters, Smith no. 1020. Taveuni, borders of lake east of Somosomo, elevation 700-900 meters, Smith no. 930.

Callicostella papillata (Montagne) Mitten form **longifolia** Fleischer.

Vanua Levu: Thakaundrove, southwestern slope of Mount Mbatini, elevation 300-700 meters, Smith nos. 629, 634; Mount Mbatini, crest of range, elevation 700-1,030 meters, Smith no. 646; southern slope of Korotini Range below Navitho Pass, elevation 300-650 meters, Smith no. 490; Mount Mariko, elevation 600-866 meters, Smith no. 473.

This form with longer, more sharply acuminate leaves seems to be prevalent in Vanua Levu but has not been noted elsewhere.

Chaetomitrium depressum Mitten.

Koro: eastern slope of main ridge, on tree trunks, elevation 300-500 meters, Smith no. 960.

Chaetomitrium rugifolium Sullivant.

Viti Levu: Naitarandamu Mountain, Namosi Province, Gillespie nos. 3307.9, 3307.5a, 3316; summit of Vakarongaseu Mountain, Gillespie no. 3297a; summit of Loma Langa Mountain, elevation 1,200 meters, Gillespie no. 3342a.

LEUCOMIACEAE

Leucomium debile (Sullivant) Mitten.

Vanua Levu: Thakaundrove, southern slope of Valanga Range, elevation 100 meters, on decayed wood, dense forest, Smith no. 369. Koro: eastern slope of main ridge, elevation 300-500 meters, on decayed wood, dense forest, Smith no. 1020a.

HYPOPTERYGIACEAE

Hypopterygium tahitense Aongstrom.

Vanua Levu: Thakaundrove, Mount Mariko, on decayed wood, Smith no. 467a.

New to Fiji. This collection agrees perfectly with Nadeaud's no. 437 from Tahiti, named by Bescherelle.

THUIDIACEAE

Pelekium velatum Mitten.

Vanua Levu: Thakaundrove, southern slope of Valanga Range, elevation 100 meters, on decayed wood, dense forest, Smith no. 369a.

Thuidium plumulosum (Dozy and Molkenboer) Bryologia javanica.

Vanua Levu: Thakaundrove, hills between Vatukawa and Wainingio Rivers, Ndrekeniwai Valley, elevation 200-500 meters, on fallen trees, forest, Smith no. 576.

Thuidium cymbifolium (Dozy and Molkenboer) Bryologia javanica.

Viti Levu: Namosi Prov., Voma Mountain, elevation 900 meters, Gillespie no. 2792.

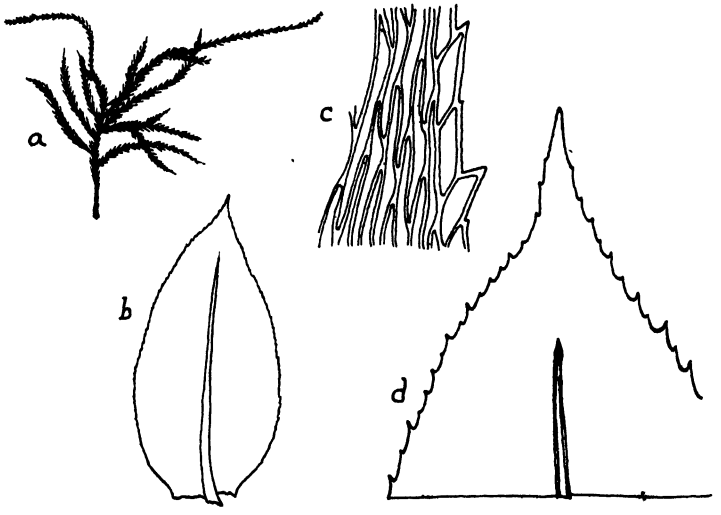

FIGURE 6.—*Rhynchostegium vitianum* Bartram and Dixon: *a*, plant, × ¾; *b*, leaf, × 22.5; *c*, upper leaf cells and margin, × 300; *d*, apex of leaf, × 120.

BRACHYTHECIACEAE

Rhynchostegium vitianum Bartram and Dixon, new species (fig. 6).

Dioicum videtur. Robustum, stramineum, nitidum. Caulis dense et irregulariter ramosus, ramis ad 1.5 cm longis, haud complanatis. Folia laxe disposita, ad 2 mm longa, oblongo-ovata, breviter acuminata, ubique argute serrulata; costa valida, longe infra apicem evanida, dorso apice spiniformiter exstante; cellulae lineares, circa 6 μ latae et 100 μ longae, infimae laxae, oblongae, alares haud diversae. Seta circa 3 cm longa; theca (unica) parva, brevis.

Viti Levu: mountains near Lautoka, Greenwood no. 9b (type).

Referred elsewhere[8] to *R. selaginellifolium* C. Müller. A subsequent comparison with the Hawaiian species indicates that the plants cannot be considered as conspecific. In the Fiji species the leaves are sharply and coarsely serrate, the leaf cells longer and narrower, and the costa ends in a sharp, salient prickle on the back.

SEMATOPHYLLACEAE

Meiothecium stratosum Mitten.

Vanua Levu: Mbua, southern portion of Seatovo Range, elevation 100-350 meters, on decaying wood, forest, Smith no. 1574.

New to Fiji.

Meiothecium hamatum (C. Müller) Brotherus.

Viti Levu: Namosi Prov., summit ridge of Naitarandamu Mountain, elevation 1,200 meters, on stems of *Elaeocarpus cheloniformis,* Gillespie no. 3141; summit of Vakarongaseu Mountain, elevation 900 meters on branch of tree, Gillespie no. 3297b.

New to Fiji. The curious and very characteristic recurved leaf apex of this species is apt to be deceptive unless examined with care. The actual point of the leaf is often closely curled in and difficult to see clearly in outline. While the point varies slightly in the degree of sharpness it is never obtuse on any plants in the two collections I have examined. The agreement with Plate no. 219 in the Bryologia javanica is essentially complete.

Sematophyllum incrassatum, new species (fig. 7).

Autoicum. Caespitosum, caespitibus densis, pallide lutescentibus, nitidis. Caulis repens, hic illic fusco-radiculosus, dense ramosus, ramis suberectis, ad 5 mm longis. Folia ramea conferta, erecto-patentia, oblongo-lanceolata, concava, ecostata, 1.5 mm longa; margines erecti, superne crenulato-denticulati; cellulae laevissimae, omnes incrassatae, porosae, lumine angustissime lineari, alares 3, vesiculosae. Folia perichaetialia erecta, sensim subulato-acuminata, marginibus superne argute serratis; seta intense rubra, superne subscabra, ad 1.5 cm longa; theca erecta vel inclinata.

Vanua Levu: Thakaundrove, Yanawai River region, Mount Kasi, elevation 300-430 meters, on decayed wood, dense brush, Smith no. 1771a (type).

The longer leaves and even more incrassate leaf cells with narrow,

[8] Dixon, H. N., The Mosses of Fiji: Linnean Soc. New South Wales, Proc., vol. 55, pt. 3, p. 300, 1930.

almost filiform lumens, will separate this species from *S. microcladioides* Brotherus to which it is closely allied.

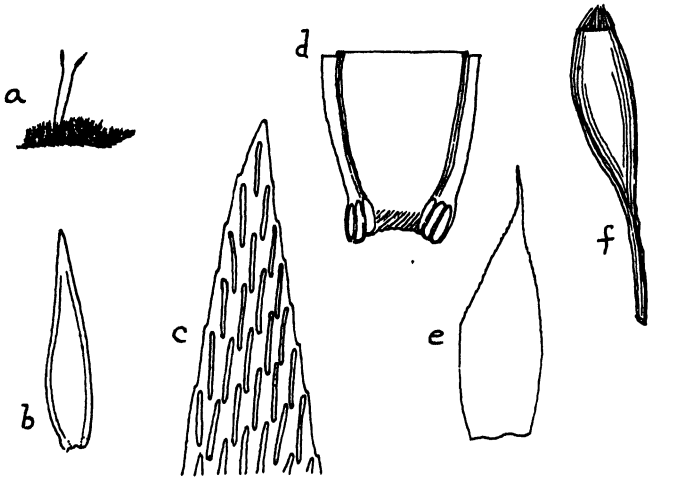

FIGURE 7.—*Sematophyllum incrassatum* Bartram: *a*, plant, × ¾; *b*, leaf, × 22.5; *c*, apex of leaf, × 300; *d*, base of leaf, × 120; *e*, perichaetial leaf, × 22.5; *f*, capsule, × 22.5.

Rhaphidostichum bunodiocarpum (C. Müller) Fleischer.

Vanua Levu: Thakaundrove, Natewa Peninsula, Uluingala, elevation 600-820 meters, on tree trunks, dense forest, Smith no. 1988, 1992; Mount Ndikeva, elevation 800 meters, on humus, crest thickets, eastern buttress, Smith no. 1887.

New to Fiji. These ample collections in fine fruiting condition indicate a generous although previously unknown distribution in the Fiji group. I have tentatively included the following well-marked variants within the specific concept but a critical revision of the genus may be necessary to establish more closely their natural affinities.

Rhaphidostichum bunodiocarpum (C. Müller) Fleischer variety **scabriseta,** new variety.

Seta circa 1.5 cm alta, superne humiliter tuberculosa.

Taveuni: summit of Uluingalau, elevation 1,000-1,220 meters, on humus, dense forest, Smith no 902 (type), 898.

This seems to be an extreme variant with shorter setae which are scabrous above or, in some cases, half-way down. Without any correlating features this character can hardly be considered of prime importance.

Rhaphidostichum bunodiocarpum (C. Müller) Fleischer variety **convolutum,** new variety.

Folia angustiora, sensim acuminata, divaricata vel deflexa, arcte convoluta.

Vanua Levu: Thakaundrove, Mount Ndikeva, elevation 900 meters, on decayed wood, crest thickets, eastern buttress, Smith no. 1882.

While differing markedly from the typical form in appearance the leaves are not uniformly deflexed and occasionally verge toward the customary shape.

Rhaphidostichum theliporum (C. Müller) Brotherus (Syn. *R. pallidifolium* Dixon).

Vanua Levu: Thakaundrove, Natewa Peninsula, hills west of Mbutha Bay, elevation 150-350 meters, on decayed wood, forest, Smith no. 834; Mathuata, Wainunu-Ndreketi divide, elevation 200-300 meters, on rocks, dense forest, Smith no. 1843.

Both collections of this little-known species agree closely with each other and with material from the type collection for which I am indebted to Dr. Reimers. The density and direction of the leaves varies, within reasonable limits, on different stems in the same tuft and can hardly be construed as a character of major importance. Under these circumstances it would seem that *R. pallidifolium* Dixon may safely be merged with Müller's species with which it agrees in color and vegetative details.

Rhaphidostichum luxurians (Dozy and Molkenboer) Fleischer.

Taveuni: with fern (*Hymenophyllum australe*) Gillespie no. 5125.

New to Fiji. Previously known from Sumatra and Java.

Trichosteleum hamatum (Dozy and Molkenboer) Jaeger.

Numerous collections from Vanua Levu and Taveuni.

Trichosteleum monostichum (Thwaites and Mitten) Brotherus.

Vanua Levu: Thakaundrove, Natewa Bay region, hills west of Korotasere, elevation 100-300 meters, on tree trunks, Smith no. 1935; Mount Mariko, elevation 600-866 meters, on wood, Smith nos. 438, 456; Yanawai River region, Mount Kasi, elevation 300-430 meters, on humus, Smith no. 1811; Mbua, southern portion of Seatovo Range, elevation 100-350 meters, Smith no. 1534; Mathuata, Wai-

nunu-Ndreketi divide, elevation 200-300 meters, on decayed wood, Smith no. 1844.

Fleischer pertinently suggests that this species is probably a variety of *T. Boschii* with longer pointed leaves. This may prove to be true but the above series certainly represents quite a distinct variant from the plant figured on p. 274 of the Bryologia javanica and from the few authentic specimens I have seen. Dr. Smith's collections are reminiscent of *Taxithelium papillatum* in some ways but the short, slender setae slightly scabrous at the tip and the long beaked lid (when present) leave no doubt as to their natural affinity. The species is new to Fiji.

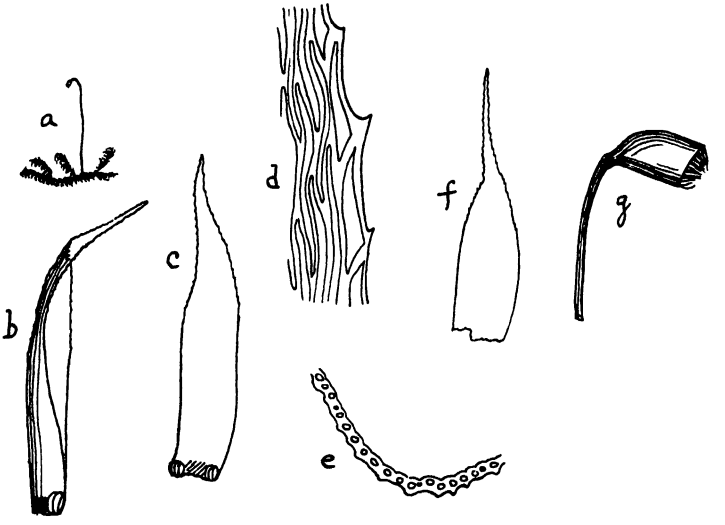

FIGURE 8.—*Trichosteleum Smithii* Bartram: *a*, plant, × ¾; *b-c*, leaves, × 22.5; *d*, upper leaf cells and margin, × 300; *e*, part of cross section of leaf above middle, × 300; *f*, perichaetial leaf, × 22.5; *g*, capsule, × 12.

Trichosteleum Boschii (Dozy and Molkenboer) Jaeger variety **minus** Dixon.

Vanua Levu: Thakaundrove, Natewa Peninsula, Uluingala, elevation 600-820 meters, on tree trunk, Smith no. 2004.

Trichosteleum Smithii, new species (fig. 8).

Autoicum. Robustiusculum, dense caespitosum, stramineum, nitidum. Caulis dense ramosus, ramis dense foliosus. Folia falcato-secunda, 2 mm longa, e basi oblongo-ovata sensim acuminata, superne argute denticulata; cellulae

lineares, humillime unipapillosae, alares vesiculosae, fuscae. Folia perichaetialia in subulam loriformem denticulatam producta; seta tenuis laevis, ad 14 mm longa; theca parva, inclinata, asymmetrica, sicca sub ore constricta; operculum longe subulato-rostratum.

Vanua Levu: Thakaundrove, Mount Mariko, elevation 600-866 meters, on decayed wood, Smith no. 428 (type).

This species has no parallel in the adjacent regions with which I am familiar. The papillae of the leaf cells are scarcely visible except in profile where they show as broad, rounded projections apparently central over the lumens.

Trichosteleum angustifolium, new species (fig. 9).

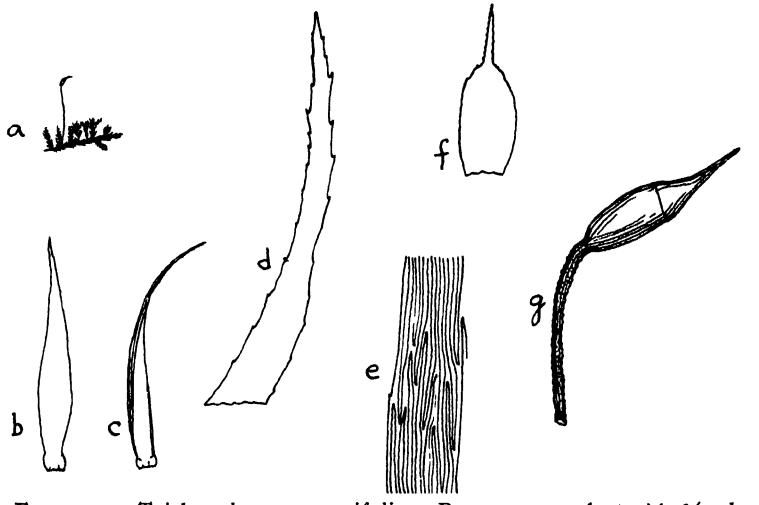

FIGURE 9.—*Trichosteleum angustifolium* Bartram: *a*, plant, × ¾; *b-c*, leaves, × 22.5; *d*, apex of leaf, × 120; *e*, upper leaf cells and margin, × 300; *f*, perichaetial leaf, × 22.5; *g*, capsule, × 12.

Autoicum. Gracile, dense caespitosum, aureo-lutescentibus, subnitidum. Caulis ruber, ramosus, ramis brevibus. Folia falcatula, 1.5 mm longa, e basi anguste ovali, concava, in subulam longam, loriformem, denticulatam, sensim contracta; cellulae angustissime lineares, laeves, alares vesiculosae, hyalinae. Folia perichaetialia vix ultra 1 mm longa, e basi ovali subito in subulam loriformem, arcte denticulatam contracta; seta 10-12 mm longa, superne scabra; theca parva, inclinata, subcylindrica; operculum longe subulato-rostratum.

Taveuni: summit of Uluingalau, elevation 1,000-1,220 meters, on humus, dense thickets, Smith no. 897 (type), 901.

While suggestive of *T. fissum* Mitten in size, color, and the coarsely-toothed perichaetial leaves, this species is amply distinguished by the narrower leaves with longer points, the very long, narrow leaf cells which are entirely smooth, and the longer setae.

Trismegistia complanatula (C. Müller) C. Müller.

Viti Levu: six miles from Suva, base of tree in forest, C. H. Edmondson.

Acroporium lamprophyllum Mitten.

Vanua Levu: Mbua, southern slope of Mount Seatura, elevation 600-700 meters, on decaying wood, Smith no 1676; Navotuvotu, summit of Mount Seatura, elevation 700-830 meters, Smith no 1662, 1673. Taveuni: Summit of Uluingalau, elevation 1,000-1,220 meters, Smith no. 911a (a very slender form); borders of lake east of Somosomo, elevation 700-900 meters, on tree trunks, Smith no. 876.

New to Fiji. With some allowance for variation in size and habit these collections seem to be representative of the species Mitten describes from Samoa. The leaf cells may be smooth or distinctly papillose but the setae are constantly scabrous above.

Acroporium brevicuspidatum Mitten.

Vanua Levu: Thakaundrove, Mount Mbatini, elevation 700-1,030 meters, on twigs, summit, dense thickets, Smith no. 708, 710; Mount Mariko, on tree trunks, Smith no. 442b.

Acroporium perserratum, new species (fig. 10).

Dioicum? Laxe caespitosum, sordide virens, nitidum. Caulis secondarius circa 4 cm altus, ramosus. Folia erecto-patentia, anguste ovato-lanceolata, concava, 3-4 mm longa, sensim longe subulato-acuminata; margin̤ibus erectis, superne minute denticulatis; cellulae superiores breviter lineares, humillime unipapillosae, basilares longiores, porosae, laeves. Folia perichaetialia ad 1.5 mm longa, e basi ovata raptim in subulam loriformem argute dentatam contracta, cellulae superiores hic illic alte papillosae; seta 8-10 mm longa, laevis, apex vix scaberula; theca parva, erecta vel leniter inclinata; operculum subulato-rostratum; spori circa 25 μ.

Vanua Levu: Thakaundrove, Yanawai River region, Mount Kasi, elevation 300-430 meters, on decayed wood, dense forest, Smith no 1814 (type).

The long and slenderly acuminate leaves preclude any confusion with *A. brevicuspidatum* Mitten. It is a unique species in several

particulars and I know of nothing else with which it can be compared. The opaque, relatively short leaf cells are turgid or papillose on the back so that the dorsal surface of the leaf presents a peculiar wavy appearance in profile while the cells of the coarsely toothed subula of the perichaetial leaves are often sparsely but coarsely papillose.

Taxithelium samoanum (Mitten) Brotherus.

Vanua Levu: Thakaundrove, southern slope of Korotini Range, below Navitho Pass, elevation 300-650 meters, Smith no. 492b. Vanua Mbalavu: northern limestone section, elevation 0-200 meters, on tree trunks, Smith no. 1473 in part, 1478 in part.

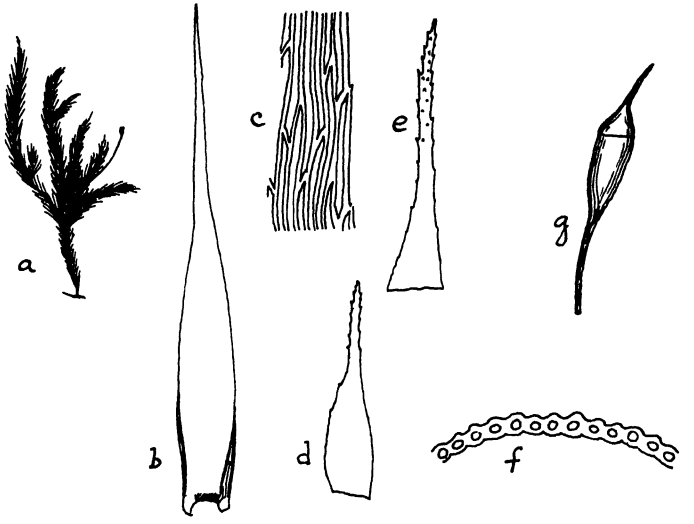

FIGURE 10.—*Acroporium perserratum* Bartram: *a*, plant, × ¾; *b*, leaf, × 22.5; *c*, upper leaf cells and margin, × 300; *d*, perichaetial leaf, × 22.5; *e*, apex of perichaetial leaf, × 60; *f*, part of cross section from upper part of leaf, × 300; *g*, capsule, × 12.

Taxithelium Lindbergii (Bryologia javanica) Renauld and Cardot.

Vanua Levu: Thakaundrove, Mount Mariko, elevation 600-866 meters, Smith no. 438a, 442c. Taveuni: western slope between Somosomo and Wairiki, elevation 600-830 meters, Mount Manuka, on decayed wood, Smith no. 771; borders of lake east of Somosomo, elevation 700-900 meters, on tree trunks, Smith no. 873.

New to Fiji.

Taxithelium tenuisetum (Sullivant) Mitten.

Vanua Levu: Mbua, lower Wainunu River valley, elevation 0-200 meters, Smith no. 1740; Navotuvotu, summit of Mount Seatura, elevation 700-830 meters, Smith no. 1667; southern slope of Mount Seatura, elevation 500 meters, Smith no. 1618; southern portion of Seatovo Range, elevation 100-350 meters, Smith no. 1575, 1560. Taveuni: western slope between Somosomo and Wairiki, elevation 700-900 meters, on tree trunks, Smith no. 756, 793. Koro: eastern slope of main ridge, elevation 300-500 meters, on tree trunk, Smith no. 1024. Vanua Mbalavu; northern limestone section, elevation 0-200 meters, Smith no. 1473 in part, 1478 in part.

New to Fiji. Numerous gatherings indicate that this species is well distributed throughout the archipelago.

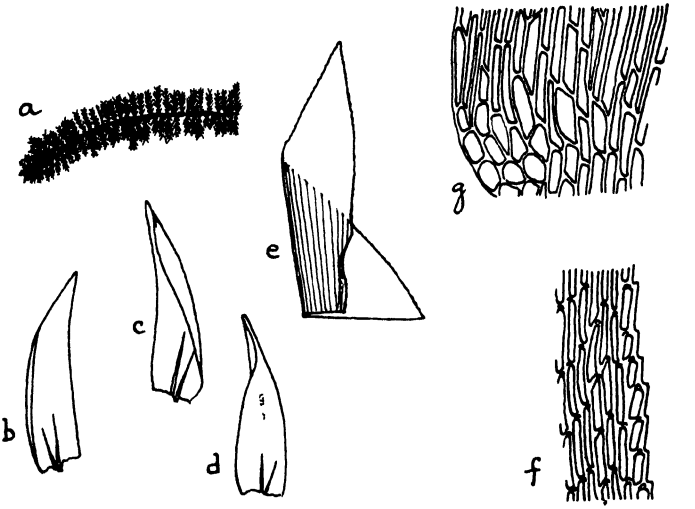

FIGURE 11.—*Glossadelphus plumosus* Bartram: *a*, plant, × ¾; *b-c-d*, leaves, × 22.5; *e*, apex of leaf, × 120; *f*, upper leaf cells and margin, × 300; *g*, basal angle of leaf, × 300.

Taxithelium herpetium (C. Müller) Brotherus.

Koro: eastern slope of main ridge, elevation 300-500 meters, on tree trunk, Smith no. 1017.

Although this collection differs from *T. tenuisetum* in the narrower leaves with a more slender acumen, the faintly papillose cells, and the few, smaller alar cells, the distinctions are not very convincing.

Glossadelphus Zollingeri (C. Müller) Fleischer variety **filicaulis** (Fleischer) Fleischer.

Vanua Levu: Thakaundrove, southern slope of Valanga Range, elevation 200-400 meters, on wet rocks, densely wooded valley, Smith no. 384.

New to Fiji. This plant has a wide distribution extending from Java to the Philippines and Hawaiian Islands.

Glossadelphus plumosus, new species (fig. 11).

Dioicus? Depressus, pallide viridis, subnitidis. Caulis repens, dense et regulariter pinnatus, ramis patulis, plumosus, sat dense foliosis. Folia erecto-patentia, oblongo-lanceolata, subacuta vel brevissime acuminata, concava, 1-1.5 mm longa; marginibus erectis, ubique arcte denticulatis; costis binis, bene notatis; cellulae lineares, ad angulos apicales valde prominentes, alares paucissime, haud distinctae. Caetera ignota.

Vanua Levu: Mbua, lower Wainunu valley, elevation 0-200 meters, on tree trunks, Smith no. 1740a (type).

A unique species with no apparent relation to any of its congeners. I hope that additional collections will be made so that its natural affinities may be clarified.

HYPNACEAE

Ectropothecium percomplanatum Brotherus.

Viti Levu: Namosi Province, Naitaradamu Mountain, elevation 900-1,200 meters, Gillespie no. 3296, 3307. Taveuni: borders of lake east of Somosomo, elevation 700-900 meters, on trees, Smith no. 923b.

Ectropothecium molle Dixon.

Vanua Levu: Thakaundrove, crest of Korotini Range between Navitho Pass and Mount Ndelaikoro, Mathuata Boundary, elevation 650-900 meters, Smith no 522; southern slope of Korotini Range below Navitho Pass, elevation 300-650 meters, on rocks, Smith nos. 572, 497; Mount Mariko, elevation 600-866 meters, on decayed wood, Smith nos. 469, 474; Mount Ndikeva, elevation 900 meters, on decayed wood, Smith no. 1883; Mbua, Navotuvotu, summit of Mount Seatura, elevation 700-830 meters, Smith nos. 1654, 1663.

If these numerous collections are properly referred here it is evidently a rather common endemic species on Vanua Levu.

Ectropothecium longicaule, new species (fig. 12).

Dioicum? Pallide lutescescens, nitidum. Caulis ad 25 cm longus, irregulariter pinnatum ramosus, ramis patulis, inequalibus, ad 2 cm longis. Folia falcatula, circa 1.5 mm longa, oblongo-ovata, concava, brevissime acuminata, superne argute denticulata; costis binis, bene notatis; cellulae angustissime lineares, laevissimae, alares paucissime, minutae, unica magna, hyalina. Folia perichaetialia erecta, ad 4 mm longa, e basi oblonga, leniter plicatula, raptim subulato-acuminata, marginibus inferne crenato-undulatis, superne irregulariter et minute spinoso-serratis; seta ad 5 cm longa, tenuis, laevis; theca inclinata, oblonga, vix 2 mm longa; operculum conico-rostratum; calyptra nuda.

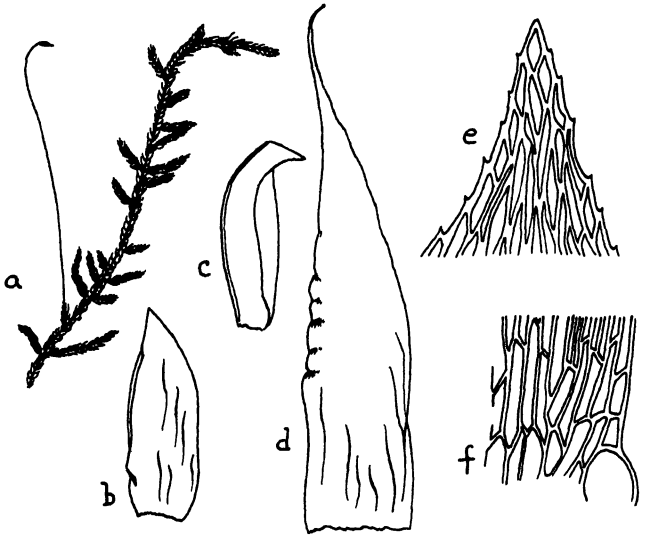

FIGURE 12.—*Ectropothecium longicaule* Bartram: *a*, part of plant, *b-c*, leaves, × 22.5; *d*, perichaetial leaf, × 22.5; *e*, apex of branch leaf, × 300; *f*, basal angle of branch leaf, × 300.

Vanua Levu: Mbua, Navotuvotu, summit of Mount Seatura, elevation 700-830 meters, on tree trunks, dense forest, Smith no. 1672 (type).

Very similar to *E. molle* Dixon but differentiated by the unusually long stems and setae and by the shorter pointed leaves.

Ectropothecium pacificum Mitten.

Vanua Levu: Thakaundrove, Mount Mariko, elevation 600-866 meters, on decayed wood, Smith no. 440. Taveuni: borders of lake east of Somosomo, elevation 700-900 meters, on decayed wood, Smith no. 927.

Ectropothecium tutuilum (Sullivant) Mitten.

Vanua Levu: Thakaundrove, southwestern slope of Mount Mbatini, elevation 300-700 meters on decayed wood, Smith no. 635.

Ectropothecium malacoblastum (C. Müller) Paris.

Vanua Levu: Thakaundrove, Mount Ndikeva, elevation 700 meters, on rocks in wet dense forest, eastern buttress, Smith no. 1893. Koro: on rocks, coastal forest, east coast, elevation, 10 meters, Smith no. 1035.

Ectropothecium cyathothecium (C. Müller) Jaeger.

Vanua Levu: Thakaundrove, Natewa Peninsula, hills south of Natewa, elevation 400-600 meters, Smith no. 1953; Yanawai River region, Mount Kasi, elevation 300-430 meters, Smith no. 1771; Mount Ndikeva, elevation 400 meters, Smith no. 1916; Mbua, southern slope of Mount Seatura, elevation 500 meters, Smith no. 1619. Koro: eastern slope of main ridge, elevation 300-500 meters, Smith nos. 991, 1066, 1052. Vanua Mbalavu: central volcanic section near Lomaloma, elevation 100-200 meters, Smith no. 1409. Moala: forest near Naroi, elevation 200 meters, Smith no. 1320.

Isopterygium minutirameum (C. Müller) Jaeger variety **vitiense** Dixon.

Vanua Levu: Thakaundrove, southern slope of Valanga range, elevation 100 meters, Smith no. 369b.

Isopterygium albescens (Schwaegrichen) Jaeger.

Kandavu: Mount Mbuke Levu, Smith no. 274.

Vesicularia vitiana (Mitten) Dixon.

Vanua Levu: Thakaundrove, Mount Mariko, elevation 600-866 meters, Smith nos. 459, 468; Mount Mbatini, elevation 700-1,030 meters, Smith no. 646a; Mount Ndikeva, elevation 500 meters, Smith no. 1904.

Veasicularia inflectens (Bridel) C. Müller.

Vanua Levu: Mbua, upper Ndama River valley, elevation 100-300 meters, on rocks in streams, Smith no. 1694.

Microctenidium Leveilleanum (Dozy and Molkenboer) Fleischer.

Vanua Levu: Thakaundrove, Mount Ndikeva, elevation 400 meters, tree trunks, eastern slope, Smith no. 1913.

A noteworthy addition to the Fiji flora. The erect capsules and single peristome with no trace of an endostome leave little doubt as to the identity of this collection. The leaf cells are more sharply spiculose by the projecting ends than might be inferred from Fleischer's description and the operculum rather longer and more slenderly beaked than indicated by the sketch and by the plate in the Bryologia javanica but I doubt if these differences are of any real import.

POLYTRICHACEAE

Pseudorhacelopus philippinensis Brotherus.

Vanua Levu: Thakaundrove, Yanawai River region, Mount Kasi, elevation 300-430 meters, on clay banks, open places in dense forest, Smith no. 1822.

Pogonatum Graeffeanum (C. Müller) Jaeger.

Koro: eastern slope of main ridge, elevation 300-500 meters, on wet stones, Smith no. 1010.

NOTES ON THE FLORA AND FAUNA OF LEHUA AND KAULA ISLANDS

By

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BERNICE P. BISHOP MUSEUM

OCCASIONAL PAPERS

VOLUME XI, NUMBER 21

HONOLULU, HAWAII

PUBLISHED BY THE MUSEUM

April 7, 1936

NOTES ON THE FLORA AND FAUNA OF LEHUA AND KAULA ISLANDS

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INTRODUCTION

Through the courtesy of Mr. F. A. Edgecomb, Superintendent of the Fourteenth Lighthouse District of the United States Department of Commerce, I was given transportation on the lighthouse tender *Kukui* when lights were established on the tiny rocky islets of Lehua and Kaula, in the spring of 1931 and the late summer of 1932. Lehua, 291 acres in extent and 702 feet high, lies just off the north point of Niihau, and Kaula, 136 acres in extent and 540 feet high, is about 23 miles west-southwest of Niihau.

In company with Dr. Harold S. Palmer of the University of Hawaii, geological, botanical, and ornithological surveys of these two islets were made, so far as I know for the first time. The results of the botanical and ornithological investigations are embodied in the accompanying notes. Unfortunately no entomological collections were made on Lehua, but the few insects collected on Kaula were reported on by Mr. E. H. Bryan Jr.[1]

The plant cover of Lehua and Kaula is rather extensive, both in quantity and in number of species, considering the adverse climatic, geologic, and faunal conditions. Only those species can survive that can endure aridity and strong, continuous winds. Consequently with very few exceptions the plants are low-growing shrubs or herbs which belong to a semi-arid or a strand flora. The boobies and frigate-birds, both of which use great quantities of nesting material, are no small factor in keeping down a vegetative cover that is scanty at best, and on Lehua, overrun as the island is by rabbits, the plants have these enemies in addition with which to contend.

The collections on which these notes are based were made during dry seasons. At other times it is not unlikely that the cover would

[1] Haw. Ent. Soc., Proc. for 1932, vol. 8, no. 2, p. 245, 1933.

appear much more extensive in quantity although probably not in variety. On Kaula great areas are entirely barren, but a search among the rocks in apparently similar areas on Lehua usually revealed the presence of grass and sedge stubble, showing that the vegetation there would be far more conspicuous following the rains.

A comparison of the floras of these two islets is interesting. Of the 26 plant species collected on Lehua, only Jacquemontia and Waltheria are of general distribution, the others being more or less localized. On Kaula, on the contrary, localization of species is the exception rather than the rule, 11 of the 15 species found being of general distribution over the islet. Even the 2 plants of Solanum were separated by about 300 feet, and 2 of the 3 plants of Capparis were separated by almost the full length of the islet, with the third about half-way between them. Opuntia appears to be spreading on Lehua, particularly on the outer slope. There are comparatively few plants on the inner side of the crescent. The plants are tall and strong, and in a healthy and flourishing condition. On Kaula this cactus is represented by a clump covering about 300 square feet, at the northwest part of the island. In sharp contrast to the stand on Lehua, the plants are extremely poor, not over two feet tall, with the pads small and thin.

Of the 35 species of plants collected on the two islands, only 6, *Panicum lanaiense, Portulaca oleracea, Opuntia megacantha, Boerhaavia diffusa, Sida fallax*, and *Heliotropium curassavicum* are common to both. It is interesting to note that of these only Panicum makes a comparable growth in both places. Portulaca, Boerhaavia, and Sida are much more common on Kaula than on Lehua, and are more healthy and flourishing. Opuntia and Heliotropium grow better on Lehua. The difference in the number of species collected on these two islets lies mainly in the Monocotyledons, this group being represented on Lehua by four grasses, three sedges, and one fern (included here for the sake of the statistics), and on Kaula by a single grass. Lehua has 18 species of Dicotyledons compared with 14 on Kaula, but most of the species are represented by a greater number of individuals on Kaula than on Lehua. Kaula's one grass will compare in quantity favorably with the same species or with Heteropogon on Lehua.

PLANTS COLLECTED

PTERIDOPHYTA

POLYPODIACEAE

Doryopteris decipiens (Hooker) J. Smith.

Lehua: rare, a few clumps found on the inner slope near the peak, just below the crest of the ridge. Fruiting April 18, 1931, (no. 15)[2].

MONOCOTYLEDONAE

GRAMINEAE

Chaetochloa verticillata Beauvois.

Lehua: very rare, only one clump was found on a tiny ledge near the landing place. In company with Sonchus, it was growing in a soil pocket formed by a small mat of *Heliotropium curassavicum*. This species is probably a recent immigrant from Niihau. Fruiting April 19, 1931 (no. 20).

Heteropogon contortus Roemer and Schlechtendal.

Lehua: common on the outer side of East Horn, and scattering over the eastern half of the southern slope. It grows very sparingly if at all west of the median line. Fruiting April 18, 1931 (no. 8).

Panicum lanaiense Hitchcock.

Lehua: rather common along the crest of the southwest ridge and at the tip of West Horn. Most of the plants found were dead. Flowering and fruiting April 18-19, 1931 (nos. 9, 23). Kaula: of general distribution, the stand heaviest toward the north end, on the western slope. All the plants found were dead. Old fruit August 17, 1932 (no. 9).

Syntherisma debilis (Desfontaines) Skeels.

Lehua: a number of dead plants were found in a small patch near the middle of West Horn, and a single dead plant was on the crest of the southwest ridge. Old fruit April 18-19, 1931 (nos. 10, 24).

[2] Numbers in parentheses refer to field labels. Plants described are in the herbarium of Bernice P. Bishop Museum.

CYPERACEAE

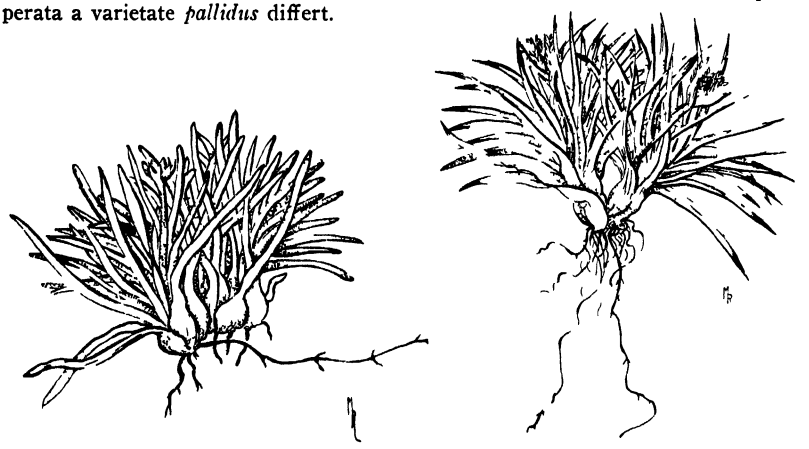
(Determined by Dr. Georg Kükenthal)

Cyperus stuppeus Forster.
(*Cyperus pennatus* Hillebrand.)

Lehua: not uncommon on the outer face of the islet, growing just below the crest near the base of East Horn, in the radial valleys of the southern slope near the cliffs, and just behind the bench to the west of the gas tank houses. In bud and old fruit April 18, 1931 (no. 5).

Cyperus polystachys Rottboell variety **pallidus** Hillebrand form **pornanus**, new form (fig. 1, *a*).

Culmo nonnisi 1 cm alto folia abscondito nec non inflorescentia depauperata a varietate *pallidus* differt.



a *b*

FIGURE 1.—Lehua: *a*, *Cyperus polystachyus pallidus* form *pornanus* Kukenthal (no. 17); *b*, *Fimbristylis cymosa pycnocephala* (Hillebrand) Kukenthal (no. 29). Natural size.

Lehua: a tiny form (the normal variety is 20 to 30 cm tall) found only near the base of East Horn, on the outer side just below the crest. Flowering April 18, 1931 (no. 17).

Fimbristylis cymosa R. Brown variety **pycnocephala** (Hillebrand) Kükenthal.

Lehua: rare, growing sparingly along the crest of the southwest ridge, where it forms mats in the tiny rock pockets. A single very

small although fully mature clump was found on the crest of West Horn, well out toward the tip. (See fig. 1, *b*.) In flower and old fruit April 19, 1931 (nos. 7, 29).

Concerning this plant Dr. Kükenthal writes: "Diese Varietät ist durch Übergangsformen deren var. umbellato-capitata (Mann) Hillebr. eng verbunden. Nur der dichtköpfige Blütenstand trennt."

Dicotyledoneae

Chenopodiaceae

Chenopodium sandwicheum Moquin.

Kaula: very common and widely distributed. Flowering and fruiting August 17, 1932 (no. 8).

Amarantaceae

Amarantus viridus Linnaeus.

Kaula: not uncommon, growing in large clumps 10 to 12 inches in diameter, scattered over the island. Flowering and fruiting August 17, 1932 (no. 2).

Nyctaginaceae

Boerhaavia diffusa Linnaeus.

Lehua: very rare, only three tiny seedlings found in the immediate neighborhood of the tank houses. One of these plants bore a single flower. Flowering April 22, 1931, (no. 28). Kaula: not common, growing mainly on the ledges near the derrick. A few very poor plants were found on the inner side of the crescent near the crest. Flowering August 17, 1932 (no. 13).

Aizoaceae

Sesuvium portulacastrum Linnaeus.

Lehua: a number of large flourishing patches grow along the southern side, in the spray of the surf, and on the crest of West Horn near the tip. Flowering April 18, 1931 (no. 4).

Portulacaceae

Portulaca caumii F. Brown.

Kaula: on the ridge, most commonly on the northern half, where mats 12 to 14 inches in diameter were found. This is the first

record of the species elsewhere than on Nihoa, the type locality. Flowering August 17, 1932 (no. 5).

Portulaca lutea Solander.

Kaula: very common and well distributed over the island. On the southwestern slope in particular the species grows in great masses in pure stand. Flowering and fruiting August 17, 1932 (nos. 4, 6).

Two plants of a somewhat different form were found, which on cursory examination seemed to represent a natural hybrid between *P. lutea* and *P. oleracea*. The material available was not sufficient for a detailed examination, and plants grown in Honolulu from cuttings of the supposed hybrid and of the typical *P. lutea* have thus far failed to flower. Vegetatively the plants are very similar, although not identical.

Portulaca oleracea Linnaeus.

Lehua: not common, although scattered the length of the crest from about the middle of the southwest ridge to near the tip of East Horn. In the main, the plants were very small and in poor condition. Flowering and fruiting April 18, 1931 (no. 11). Kaula: common on the western side of the crest, especially at the northern end, where large flourishing mats were found. Flowering and fruiting August 17, 1932 (no. 3).

Portulaca villosa Chamisso.

Lehua: rare, found only in one small stand on the crest of West Horn, near the tip. The plants were all small and in poor condition. Fruiting April 19, 1931 (no. 12).

A root, brought to Honolulu and planted, furnished a basis for the determination of the species. In addition to these plants, three small broken pieces of a Portulaca, well dried, were found lying on the ground about half way out East Horn. Old fruit April 18, 1931 (no. 1). The material collected was entirely inadequate for accurate identification, and seeds planted in Honolulu failed to germinate, but it is probable that the fragments must be referred to this species.

Papaveraceae

Argemone mexicana Linnaeus.

Lehua: rare, two plants were found in a pocket just behind the cliffs on the south side, and two more were seen in a deep gully

on the northern side of the southwest ridge. Flowering April 19, 1931 (no. 6).

This is the species which Degener[3] considers endemic, distinct from the *A. mexicana* of Linnaeus, and which he names, without description, *Argemone glauca.*

Capparidaceae

Capparis sandwichiana De Candolle.

Kaula: rare, only three plants were found, one near each end of the island and one about midway between. They were all small, the stems not more than a foot long, although one had a trunk about 1¾ inches in diameter. Flowering August 17, 1932 (no. 1).

Zygophyllaceae

Tribulus cistoides Linnaeus.

Kaula: rather common on the ledges near the derrick, and scattered elsewhere. In flower and green fruit August 18, 1932 (no. 14).

Euphorbiaceae

Euphorbia celastroides Boissier.

Kaula: well distributed over the island. The plants were all very low and sprawling, with heavy stems. Flowering August 17, 1932 (no. 10).

Euphorbia hirta Linnaeus.

Lehua: not uncommon, scattered along the crest of the island, and very sparingly elsewhere. The plants were all small and distinctly prostrate. Flowering and fruiting April 18, 1931 (no. 13).

Malvaceae

Sida fallax Walpers.

Lehua: rare, two plants were found near the tip of East Horn, on the inner side, and one dead plant and several small seedlings near the tip of West Horn, on the crest. In flower and fruit April 18, 1931 (no. 18). Kaula: not common, and apparently restricted to the northern end. Several plants were found which bore flowers

[3] Degener, Otto, Ferns and flowering plants of Hawaii National Park, Honolulu, p. 164, 1930.

with petals rather narrower at the base and more widely spread apart than is usual. Flowering August 17, 1932 (nos. 11, 11a).

STERCULIACEAE

Waltheria americana Linnaeus.

Lehua: very common in all parts of the islet with the exception of the farther part of West Horn, where it occurs very sparingly. With the exception of Jacquemontia it is the commonest plant species on the island. Flowering April 18, 1931 (no. 3).

CACTACEAE

Opuntia megacantha Salm-Dyck.

Lehua: common on the southern and eastern faces of the islet, and a few scattered clumps on the inner side of the crescent near the base of West Horn. Flowering April 18, 1931 (not collected). Kaula: a single rather small, scrubby patch near the northern end of the island. Flowering August 17, 1932 (not collected).

ASCLEPIADACEAE

Asclepias curassavica Linnaeus.

Lehua: rare, a few plants only having been found in a clump of Opuntia well down on the southern slope, east of the landing. In flower and old fruit April 20, 1931 (no. 25).

CONVOLVULACEAE

Ipomoea indica (Burmann) Merrill.

Kaula: not common, a few rather long-stemmed plants on the ledges near the derrick, and a few very small plants elsewhere. Sterile August 17, 1932 (no. 12).

Ipomoea pes-caprae Roth.

Lehua: rare, only one small patch having been found on the inner side of the base of West Horn, about 200 feet below the summit. Flowering April 22, 1931 (no. 27).

Jacquemontia sandwicensis Gray.

Lehua: the prevailing plant, common in all parts of the island except the tip of West Horn. Flowering and fruiting April 19, 1931 (no. 2).

BORAGINACEAE

Heliotropium anomalum Hooker and Arnott.

Lehua: restricted to the inner side of the crescent. From the base of East Horn westward to about the median line, on the rocks of the pre-summit series, it forms an almost pure stand. From there nearly to the base of West Horn, and above the heavy stand, it grows sparingly. Flowering and fruiting April 18, 1931 (no. 16).

Heliotropium curassavicum Linnaeus.

Lehua: uncommon, growing in a few places on the southern cliffs, in the neighborhood of the landing, just above the water. Flowering and fruiting April 19, 1931 (no. 19). Kaula: very rare, only two plants having been found, well out on East Horn. Flowering August 17, 1932 (no. 7).

VERBENACEAE

Lantana camara Linnaeus.

Lehua: very rare. Only one plant was seen, in a soil pocket on the edge of the southern cliffs, west of the tank houses. This plant was destroyed after specimens had been taken. Sterile April 20, 1931 (no. 26).

Mr. Aubrey Robinson, the owner of the island of Niihau, has for a number of years conducted a systematic campaign of extermination against lantana on Lehua, to prevent the spread of the plant to Niihau.

SOLANACEAE

Solanum nigrum Linnaeus.

Kaula: very rare, only two plants having been found, one on the ledge near the derrick, the other about three fourths of the way up the western face. Flowering and fruiting August 18, 1932 (no. 15).

CUCURBITACEAE

Sicyos sp.

Lehua: rare, found in only one place, in an Opuntia thicket at the foot of a radial valley just to the west of the tank houses. The vines were all dead, cut off at the base apparently by rabbits. They were sterile, and definite determination was not possible. April 19, 1931 (no. 22).

COMPOSITAE

Ageratum conyzoides Linnaeus.

Lehua: uncommon, scattered sparingly along the crest of the islet, and a few larger and more vigorous plants in the deep gulches on the inner side of West Horn. Flowering and fruiting April 18, 1931 (no. 14).

Sonchus oleraceus Linnaeus.

Lehua: very rare, only two plants having been found on a tiny ledge near the landing. Like the Chaetochloa with which it was associated, this plant is probably a recent immigrant from Niihau. Fruiting April 19, 1931 (no. 21).

LIST OF BIRDS

Anous stolidus (Linnaeus) *Laridae.* Noddy Tern.

Lehua: fairly common, nesting in deep caves near the landing, and a few under overhanging rocks in the valleys to the west of the tank houses. Kaula: the most numerous species on the island, distributed everywhere, but centering on the face of the islet toward the southern end.

Gygis alba kittlitzi Hartert *Laridae.* White Tern; Love-bird.

Kaula: not common, a few in the cliffs toward the center of the inner slope of the crescent.

Micranous hawaiiensis Rothschild *Laridae.* Noio; Hawaiian Tern.

Lehua: rather rare, nesting with the noddys in the deep caves near the landing.

Procelsterna saxatilis Fisher *Laridae.* Necker Island Tern.

Kaula: a small colony living in the steep cliffs at the North Horn.

Sterna fuliginosa Gmelin *Laridae.* Sooty Tern.

Kaula: rather common, mainly on the face of the islet, in the central part and toward the south.

Sterna lunata Peale *Laridae.* Gray-backed Tern.

Kaula: not common, mainly on the crest north of the center.

Diomedea nigripes Audubon *Diomedeidae.* Brown Gooney; Black-footed Albatross.

Lehua: only a few birds seen, and none known to be nesting on

the islet. Kaula: none seen, but one old egg was found, indicating that the islet is visited.

Pterodroma leucoptera hypoleuca (Salvin) *Procellariidae.* Bonin Island Petrel.

Kaula: one chick, which I believe to be of this species, was found in a shallow cave on the inner slope of the crescent. No adult birds were noted.

Bulweria bulweri (Jardin and Selby) *Procellariidae.* Bulwer's Petrel.

Kaula: several individuals were seen in flight, and one chick which appeared to be of this species was found on a ledge on the outer face of the islet.

Puffinus pacificus cuneatus (Salvin) *Procellariidae.* Uau kane; Wedge-tailed Shearwater.

Lehua: very common, nesting in fault-cracks along the crest of the islet and in the soil in the radial valleys of the southern slope. Kaula: only two individuals were seen, but there were many unoccupied burrows, showing that during the breeding season they visit the island in appreciable numbers.

Phaethon rubricauda (Boddaert) *Phaëthontidae.* Koae; Bos'n; Red-tailed Tropic Bird.

Lehua: probably the commonest species on the islet, nesting in caves and under overhanging rocks everywhere. Kaula: rather common along the inner side of the crescent.

Sula cyanops (Sundevall) *Sulidae.* Blue-faced Booby.

Lehua: only a few individuals seen. Two or three pairs were nesting with the iwa and common boobies at the southeast corner of the islet. Kaula: rather common, mainly along the crest near the East Horn, and at the edge of the high cliff toward the northern end.

Sula piscator (Linnaeus) *Sulidae.* Red-footed Booby.

Kaula: not uncommon, on the inner slope of the islet near the East Horn.

Sula sula (Linnaeus) *Sulidae.* Common or Hooded Booby.

Lehua: not uncommon, a few pairs nesting at the southeast

corner of the islet. Kaula: very common, mainly near the north end and at the extreme tips of the two horns of the crescent.

Fregata minor palmerstoni Gmelin *Fregatidae.* Iwa; Frigate-bird; Man-o'-War Hawk.

Lehua: rare, only a few individuals seen. Two or three pairs were nesting in a patch of Sesuvium on the edge of the cliff at the southeast corner of the islet. Kaula: very common along the inner side of the crescent from the center toward the East Horn.

Pluvialis dominicus fulvus (Gmelin) *Charadriidae.* Kolea; Pacific Golden Plover.

Kaula: several individuals seen on the shelf along the inner curve of the crescent, just above the surf.

Arenaria interpres (Linnaeus) *Charadriidae.* Akekeke; Turnstone.

Lehua: several individuals seen, apparently visitors from Niihau.

Alauda arvensis Linnaeus *Alaudidae.* Skylark.

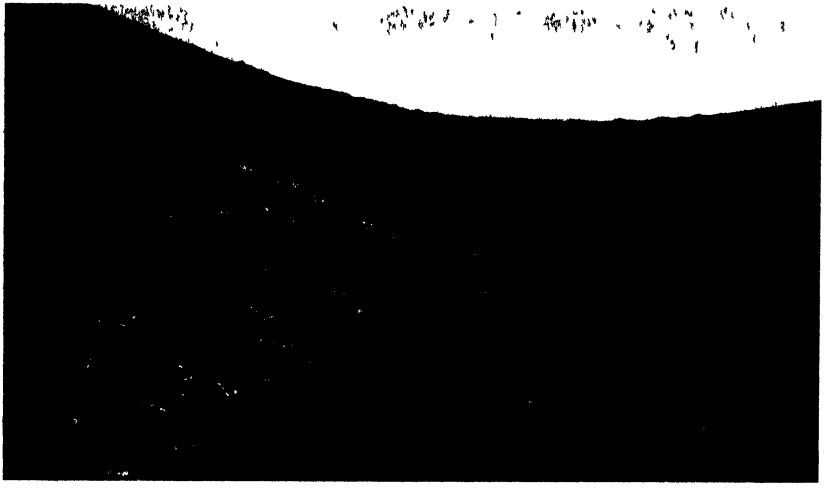
Lehua: rather common. Many are certainly visitors from Niihau, as they were seen to cross the channel between the islands, but a few pairs were nesting in the cactus clumps on the southern slope.

It might be noted that both families of lizards known in Hawaii, the Gekkonidae and Scincidae, are represented on Lehua, but apparently only the geckos have reached Kaula, as no skinks were seen. None were collected, so that no specific determinations were made. The geckos were scarce, only two individuals having been seen on Lehua and one on Kaula, but on Lehua the skinks were common, flashing about among the rocks in all parts of the islet. I saw no mammals of any sort on Kaula, although the lighthouse personnel more recently have reported the presence of a small rat which, from their description, is probably the native Hawaiian rat. Lehua was overrun with rabbits, and I have heard that rats are present there, but I saw no traces of them.

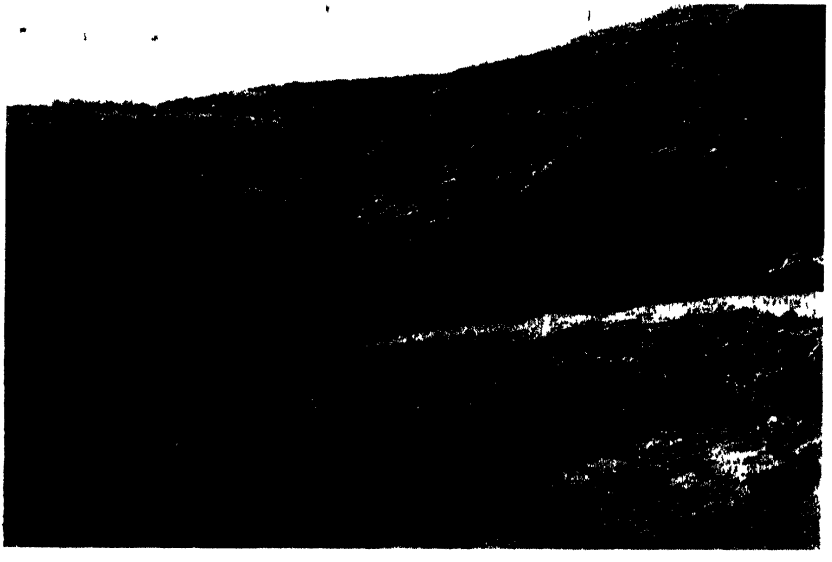
A

B

PLATE 1.—*Opuntia megacantha* *A* Lehua at the foot of a radial valley on the southern slope, *B*, Kaula, stand of *Opuntia megacantha* with a mat of *Portulaca oleracea* in the left foreground and *P lutea* in the center and to the right

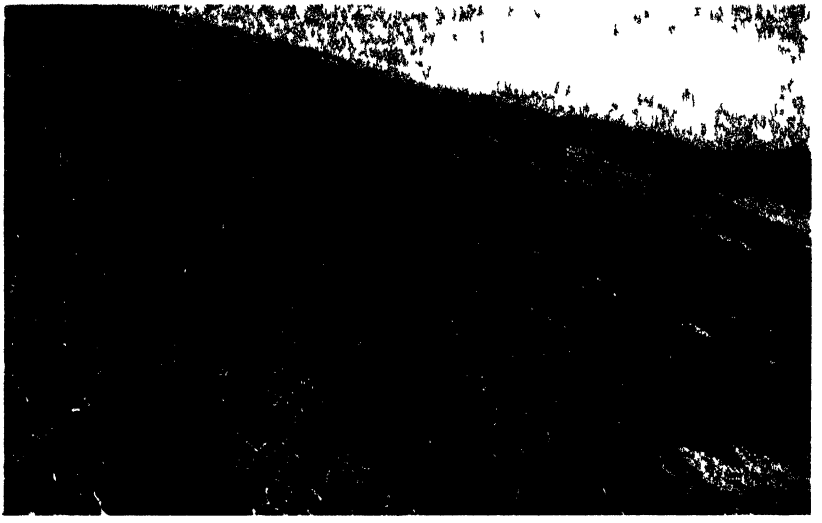


A



B

PLATE 2.—Lehua: *A, Heliotropium anomalum* on the eastern half of the inner slope of the islet; *B, Cyperus stuppeus* and *Jacquemontia sandwicensis* in a small cove on the southern shore.



A

B

PLATE 3—Kaula *A* a heavy stand of *Portulaca lutea*, *B*, *Portulaca oleracea* in the middle foreground, with *Panicum lanaiense* to the right, *Portulaca caumii* in the center, small plants of *Sida fallax* behind

A NEW SPECIES OF SCHIEDEA

By

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BERNICE P. BISHOP MUSEUM

OCCASIONAL PAPERS

VOLUME XI, NUMBER 23

HONOLULU, HAWAII

PUBLISHED BY THE MUSEUM

April 10, 1936

A NEW SPECIES OF SCHIEDEA

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Schiedea kealiae, new species.

Suffrutex ad 50 cm altus, glaber, subtus lignosus. Folia trinervata, lato-lanceolata, 4-8 cm longa, 6-11 mm lata, apice acuminatum, basi angustum. Inflorescentia terminalis, paniculata, 2-3-fid, rami oppositi, folii nodorum reducti. Pediculi semi-erecti, filiformi. Bracteoli lato-lanceolati. Sepala ovata, acuta, virida, 2.5 mm alta. Stamina et staminodia 15, biseriatim; series exteriora 5 staminodia lato-triangulares sepala opposita et 5 stamina, series interiora 5 stamina staminodiorum lata bases affixa. Styli 3-4, capsula ovoidea, semina submuricata.

An erect to semi-decumbent under-shrub, to about 50 cm tall, glabrous terete and woody below, the branches herbaceous and angular above, the nodes swollen. Leaves glabrous, dark green above, paler beneath, broad-lanceolate, 4-8 cm long, 6-11 mm wide at the widest part, acuminate at the apex, narrowed to the clasping base, this very pale in color, prominently 3-nerved, thin chartaceous, the margins thickened. Inflorescence terminal, thyrsoid paniculate, contracted, 4-8 cm high, projecting beyond the leaves, 2-3 times compound, the branches opposite, at each node of the rhachis a pair of progressively reduced leaves. Pedicels nearly erect, very slender filiform, 4-7 mm long, the broad-lanceolate bractlets 1-2 mm long by 0.5 mm wide, green with narrow hyaline margins. Sepals ovate, acute, green, 2.5 mm long by 1 mm wide, faintly 3-nerved. Staminal cup 2-ranked, the outer rank consisting of 5 broad-triangular staminodia, lying opposite the sepals, and 5 stamens alternating with them, the inner rank of 5 stamens affixed at the bases of the staminodes. Staminodes about half the length of the sepals, the stamens slightly exceeding the sepals. Styles 3 or 4, about 1 mm long, curling. Capsule ovoid-pyramidal, 3 mm high, enclosed by the calyx, splitting at maturity into valves corresponding in number to the styles, the free-central placenta split into several bristle-like processes. Seeds minute, orbicular-reniform, brown, crustaceous, slightly muricate.

Oahu, Waianae Mountains, on dry cliffs and among rocks along the trail on the Kealia side of the Kaena-Kealia boundary ridge, where it forms a conspicuous part of the vegetation at elevations of 500 to 800 feet, growing in company with *Bidens, Lepidium, Eragrostis* and other plants that favor such a location. Collected February 14, 1913, by C. N. Forbes no. 1838-O, H. A. Pilsbry and C. M. Cooke, Jr. at Kawaihapai (probably at or very near the type station); September 23, 1931, O. Degener no. 5923; September 25, 1934, E. H. Bryan, Jr. no. 786, O. H. Swezey and d'A. A. Welch; August 4, 1935, E. Y. Hosaka no. 1292; February 2, 1936, F. R. Fosberg no. 12853; February 2, 1936, E. Y. Hosaka no. 1320 (type in B. P. Bishop Museum).

FIGURE 1—*Schiedea kealiae*: *a*, habit; *b*, *c*, flower; *d*, capsule; *e*, seed.

Schiedea kealiae is closely allied to *S. ligustrina* Chamisso and Schlechtendal and *S. hookeri* Gray, both from the same general region. From *S. ligustrina* it differs principally in the wider triplinerved leaves and the more open panicle, and from *S. Hookeri* principally in the much more contracted almost glabrous panicle.